Customer Care Solutions
RM-37 Series Transceivers

6-Troubleshooting Instructions

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RF Troubleshooting

Introduction to RF troubleshooting

Measurements should be done using Spectrum analyzer with high-frequency high-impedance passive probe (LO-/reference frequencies and RF power levels) and Oscilloscope with a 10:1 probe (DC-voltages and low frequency signals)

The RF-section is build around one RF-ASIC (HELGA N500). For easier troubleshooting, this RF troubleshooting document is divided in to sections.

Before changing HELGA, please check following things: Supply voltages are OK and serial communication coming from baseband to HELGA.

Please note that the grounding of the PA module is directly below PA-module so it is difficult to check or change. **Most RF semiconductors are static discharge sensitive!** So ESD protection must be taken care of duriong repair (ground straps and ESD soldering irons). HELGA and PA are moisture sensitive so parts must be pre-baked prior to soldering.

Apart from key components described in this document here are a lot of discrete components (resistors, inductors and capacitors) which troubleshooting is done by checking if soldering of the component is done properly (for factory repairs checking if it is missing from PWB). Capacitor can be checked for shortening and resistors for value by means of an ohmmeter, but be aware in-circuit measurements should be evaluated carefully.

Please be aware that all measured voltages or RF levels in this document are rough figures. Especially RF levels varies due to different measuring equipment or different grounding of the used probe. When using RF probe usually a good way is to use metallic tweezers to connect probe ground to PWB ground as close to measurement point as possible.

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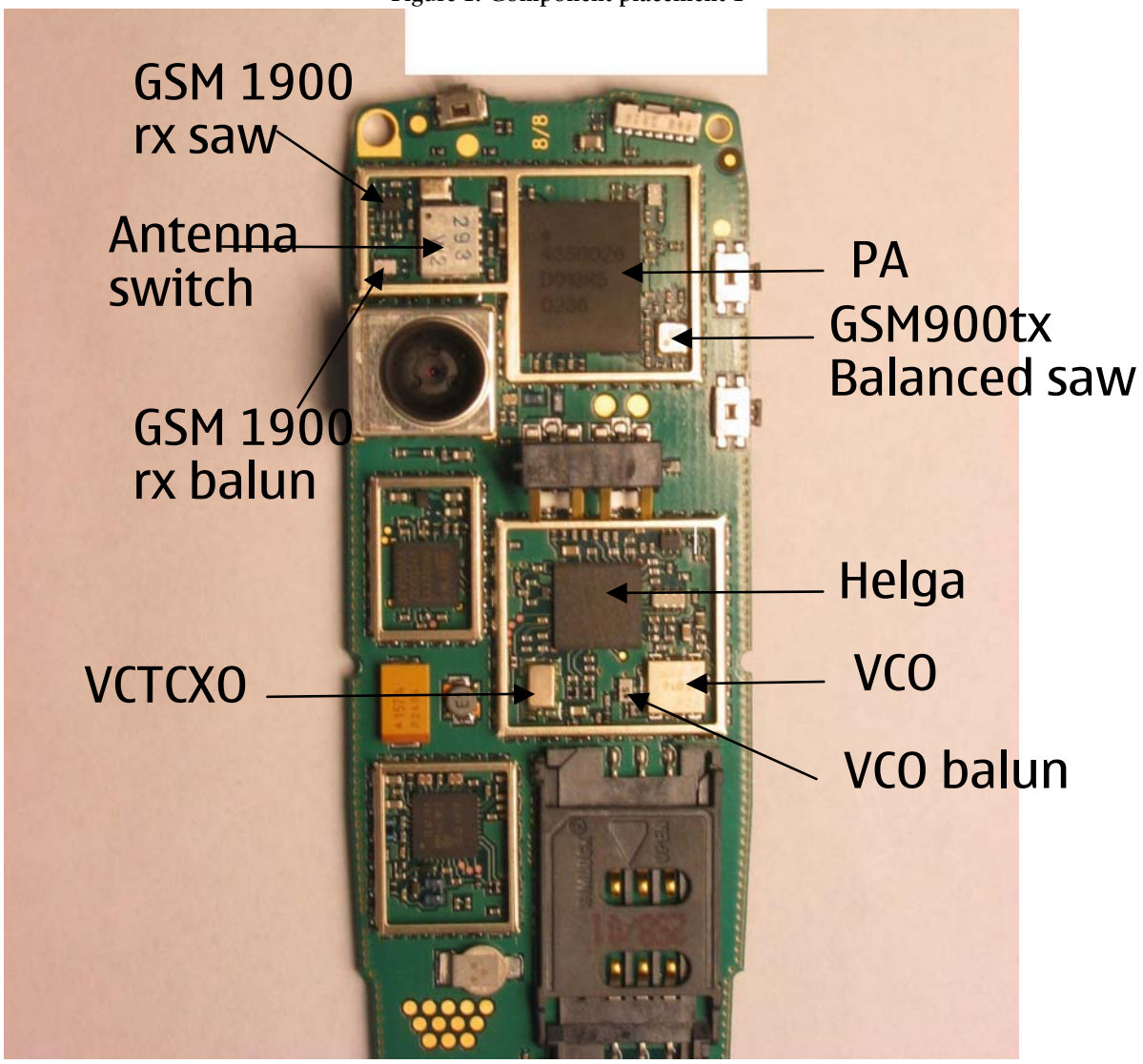
RF Key component placement

Figure 1: Component placement 1



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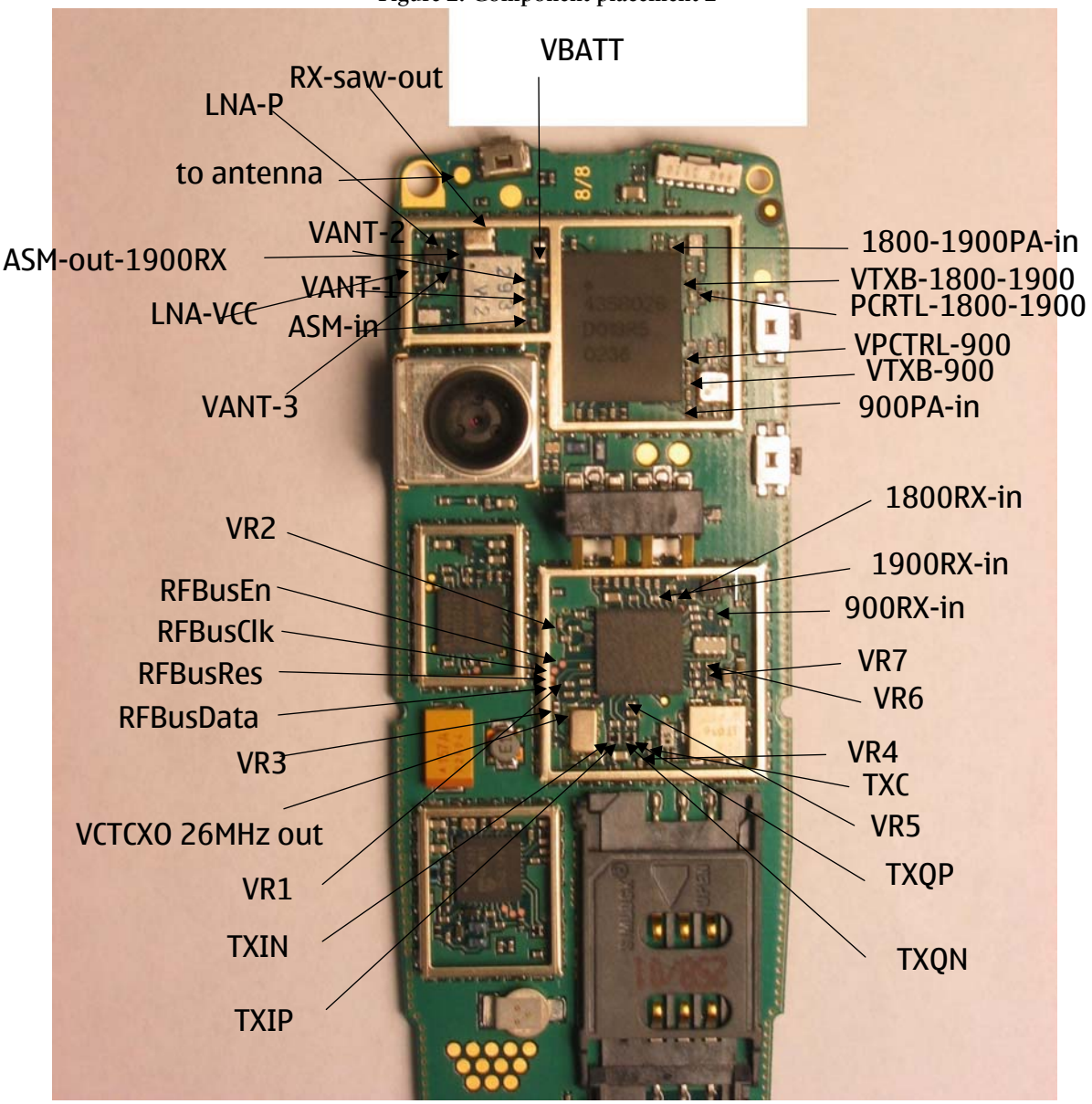
RF Measurement points

Figure 2: Component placement 2



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GSM900 & GSM1800 Transmitter

General instructions for Tx troubleshooting

Kindly refer to the Service Software Section, Service Concept dagram (p.40)

Connect test jig to computer with DAU-9S cable or to FPS-8 Flash Prommer with XCS-4 modular cable.

Make sure that you have PKD-1 dongle connected to computers parallel port.

Connect DC power supply to module test jig with FLC-2 cable.

Attention: When repairing or tuning transmitter use external DC supply with at least 3A current capability. Set the DC supply voltage to 3.9V and set the jumper connector on test jig to "bypass" position.

Connect a RF-cable to the module test jig (MJS-38) RF connector to and to measurement equipment or at least 10dB attenuator, otherfwise the PA may be damaged. Normally Spectrum analyzer is used as measurement equipment.

Attention: Normally Spectrum analyzer maximum input power is +30dBm. It is recommended to use 10dB attenuator on Spectrum analyzer input to prevent damage.

Set the phone module to test jig and start Phoenix service sofware

Initialize connection to phone. (use FBUS driver when using DAU9S and COMBOX driver when using FPS-8)

Select product from the menu

File -> Choose product -> RM-37

From toolbar set operating mode to "Local"

Activate RF controls window from the menu

Maintenance -> Testing -> RF Controls

From the RF controls window

- Select band "GSM900" or "GSM 1800" or "GSM1900" (Default = "GSM900")

- Set Active unit to "Tx" (Default = "Rx")

- Set Operation mode to "Burst" (Default = "Burst")

- Set Tx data type to "Random" (Default = "All1")

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- Set Rx/Tx channel to 37 on GSM900 band or 700 on GSM1800 band or 661 on GSM1900 (Defaults)

- Set Tx PA mode to "Free" (Default)

- Set power level to 5 (Default = 19) on GSM900 or to 0 (Default = 15) on GSM1800 or GSM1900

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Transmitter troubleshooting diagram

Figure 3: Transmitter troubleshooting

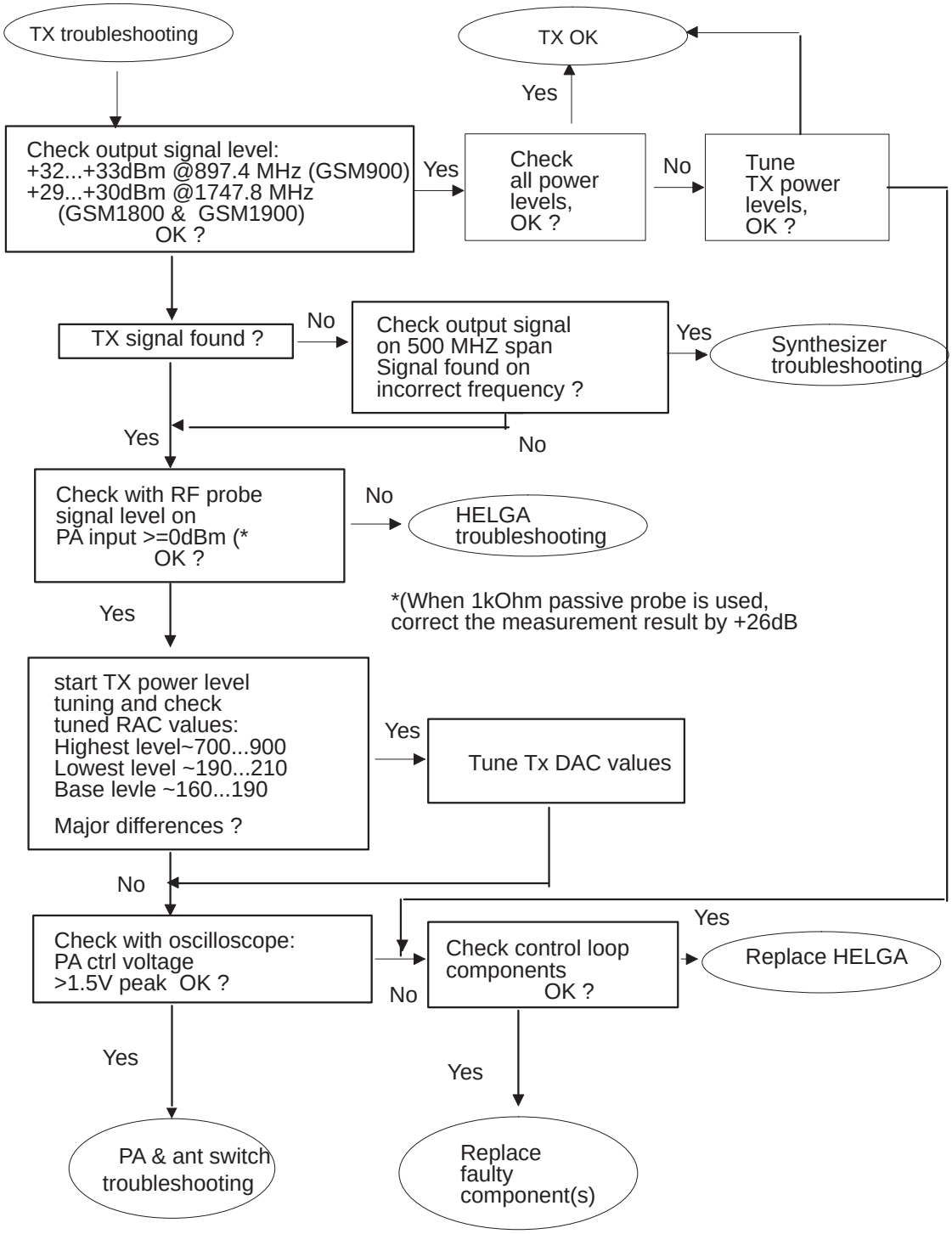


Figure 4: HELGA IC troubleshooting

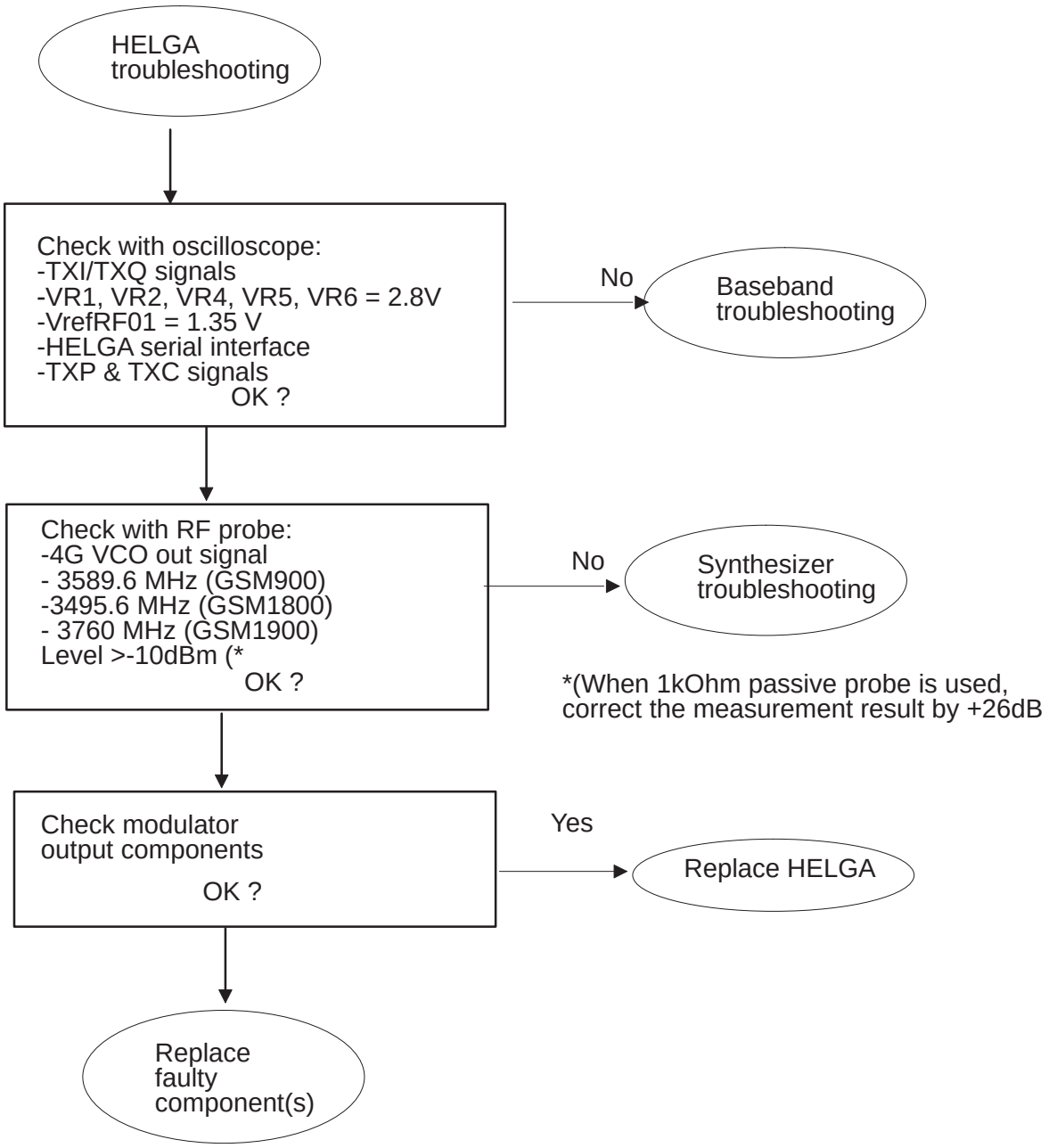
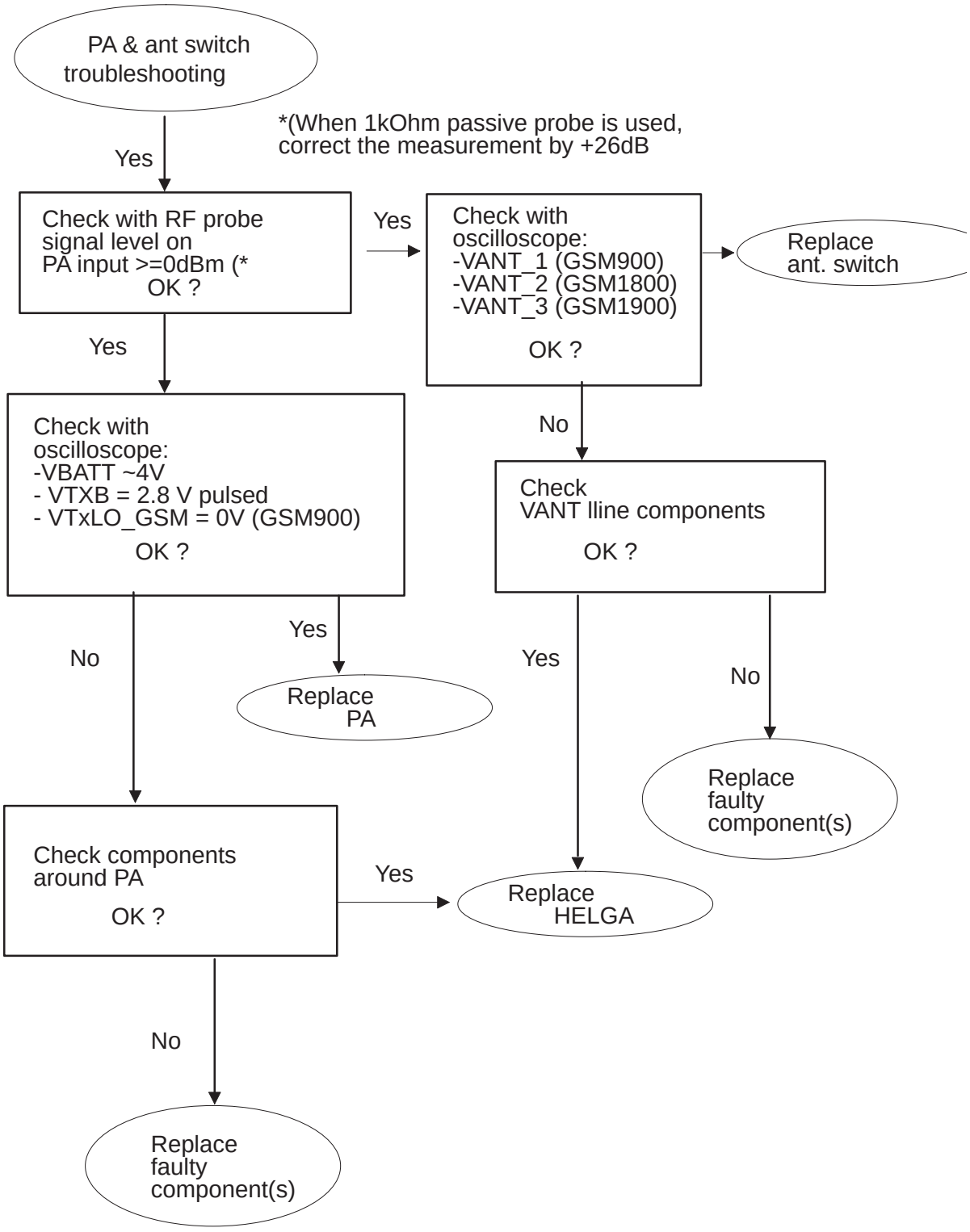
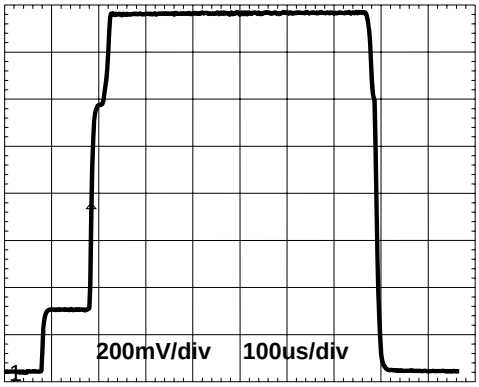


Figure 5: PA and Antenna Switch troubleshooting

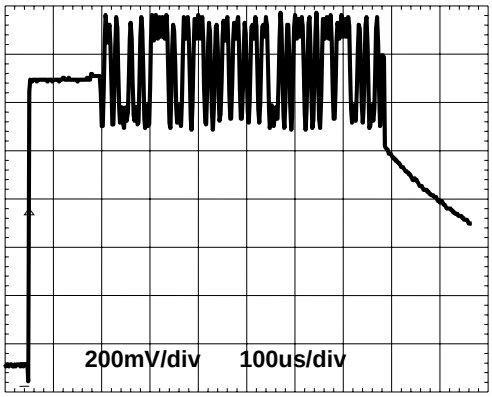

PA & ant switch troubleshooting
*(When 1kOhm passive probe is used, correct the measurement by +26dB
Yes
Check with RF probe signal level on PA input >=0dBm (* OK ?
Yes
Check with oscilloscope: -VANT_1 (GSM900) -VANT_2 (GSM1800) -VANT_3 (GSM1900) OK ?
Replace ant. switch
Yes
No
Check with oscilloscope: -VBATT ~4V - VTXB = 2.8 V pulsed - VTxLO_GSM = 0V (GSM900) OK ?
Check VANT lline components OK ?
Yes
No
Replace PA
Yes
No
Replace faulty component(s)
Check components around PA OK ?
Yes
Replace HELGA
No
Replace faulty component(s)

Pictures of transmitter signals

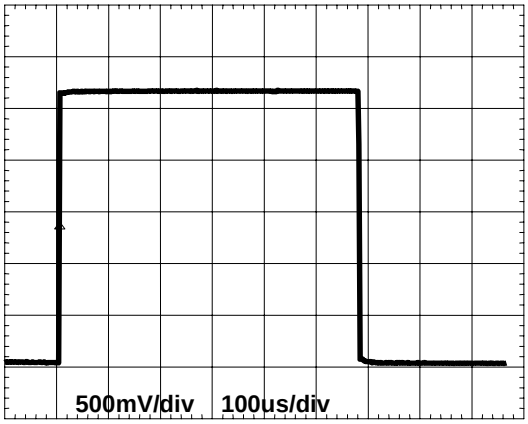
Figure 6: Transmitter signals



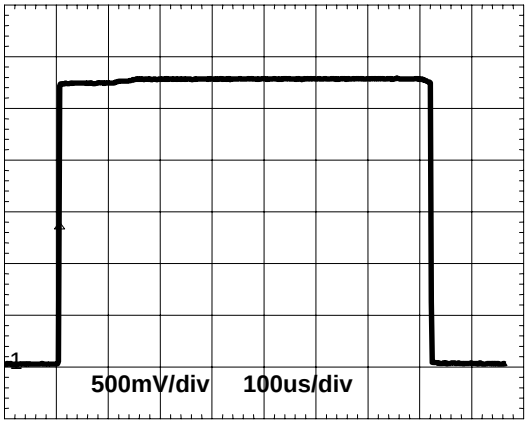
VPCTRL _900 power level high at R703/C703
VPCTRL_1800/1900 power level high at R704/C704_



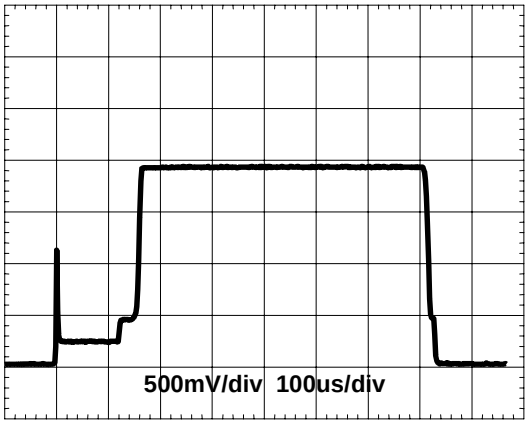
TX I/Q at R516/517 power level high Random data



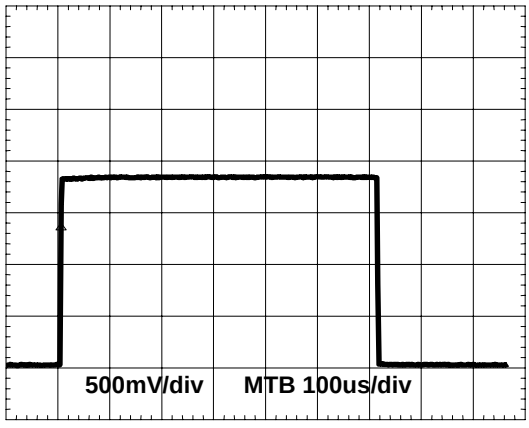
VANT_1 / GSM900 TX at C804
VANT_2 / GSM1800 TX at R808
VANT_3 / GSM1900 TX at C805 OV
(no signal/ Flatline on Oscilloscope screen)



VANT_1,VANT_2,VANT_3



VTXB_900 at C713
VTXB_1800_1900 at C714



TXP at J504

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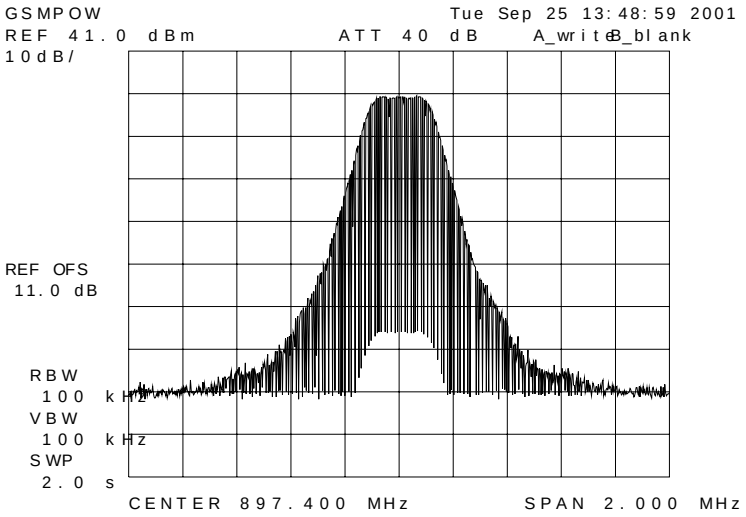
Figure 7: TX OUT signal



Tx out signal, 900 band, burst mode, channel 37

GSM900, GSM1800 and GSM1900 Receiver

General instructions for Rx troubleshooting

Connect test jig to computer with DAU-9S cable or to FPS-8 Flash Prommer with XCS-4 modular cable.

Make sure that you have PKD-1 dongle connected to computers parallel port.

Connect DC power supply to module test jig with FLC-2 cable.

Set the DC supply voltage to 6V (test jig has internal voltage regulator of output voltage 4V).

Connect an RF-cable to the module test jig (MJS-38) RF connector and to RF signal generator.

Set the phone module to test jig and start Phoenix service sofware.

Initialize connection to phone. (use FBUS driver when using DAU9S and COMBOX driver when using FPS-8)

Choose product from the menu

File -> Choose product -> RM-37

From toolbar set operating mode to "Local"

Activate RF controls window from the menu

Maintenance -> Testing -> RF Controls

From the RF controls window:

- Select band "GSM900", "GSM 1800" or "GSM1900" (Default = "GSM900")

- Set Active unit to "Rx" (Default = "Rx")

- Set Operation mode to "Burst" (Default = "Burst")

For continuous mode:

- Set Operation mode to "Continuous"

- Set AGC to "12: FEG_ON + DTOS_ON + BB_30=Vgain60" (maximum gain setting used in normal mode)

(Default = "14: FEG_ON + DTOS_ON + BB_42=Vgain72")

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- Set Rx/Tx channel to 37 on GSM900 band, 700 on GSM1800 band or 661 on GSM1900 (Defaults)

Apply 942.46771 MHz (channel 37 + 67.710 kHz offset), 1842.86771 MHz (channel 700 + 67.710 kHz offset) or 1960.06771 MHz (channel 661 + 67.71 kHz) –90 dBm signal to the RF-connector (remember to compensate for cable attenuation).

Measuring with an oscilloscope on "RXI" or "RXQ" following screens should be seen on a working GSM900 , GSM1800 or GSM1900 receiver:

Figure 8: RX I/Q signal ,burst mode, input level –90dBm.

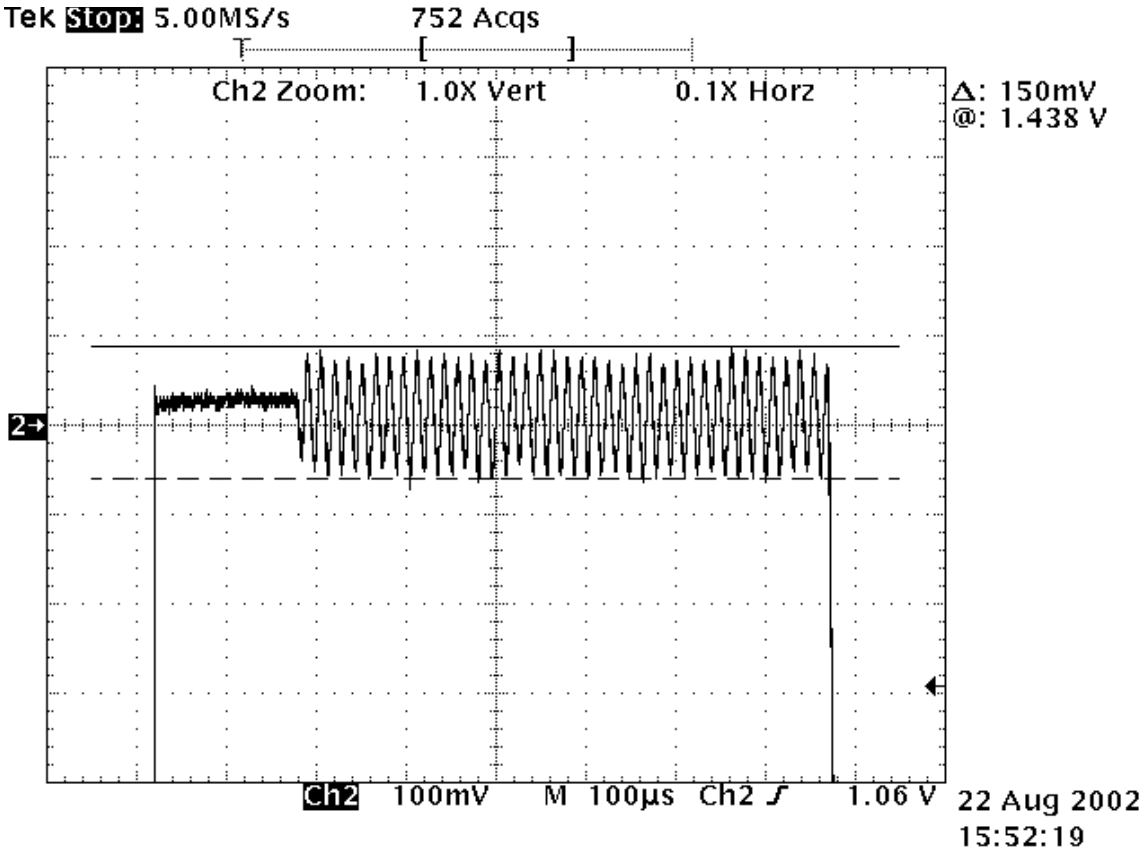


Figure 8, "RX I/Q signal ,burst mode, input level –90dBm.," on page 15: Receiver I or Q burst mode signal (channel 37) measured from testpoint RXI or RXQ with 942.467 MHz signal, input level –90dBm at RF-connector.

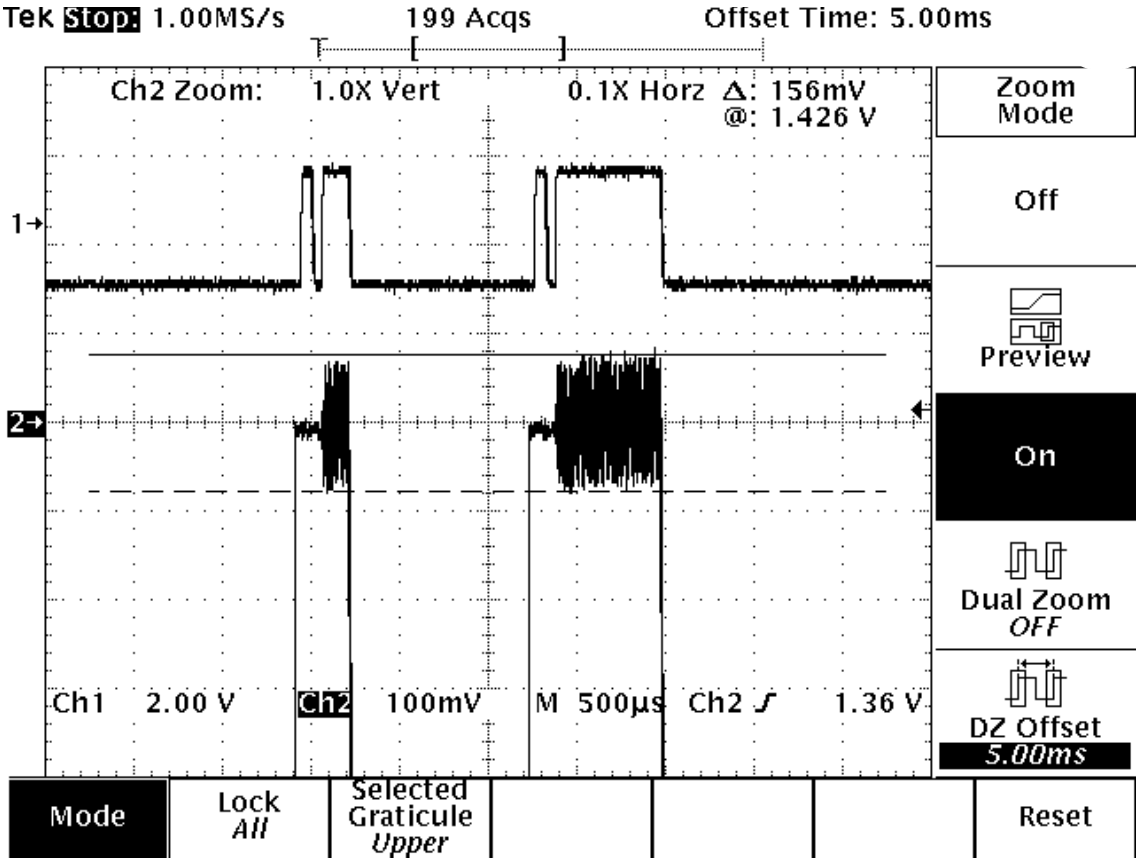
Correct signal amplitudes approximately:

- GSM900~170mVpp
- GSM1800~140mVpp
- GSM1900~160mVpp

Signal part frequency 67.7kHz sine.

DC level of signal part is 1.35V. DC level can variate about +/-100mV between I and Q signals and between different bands as well.

Figure 9: GSM1900 RX I or Q signal (trace2), burst mode.



For Figure 9, "GSM1900 RX I or Q signal (trace2), burst mode.," on page 16 GSM1900 receiver burst mode I or Q signal at ch 661 with input signal 1960.067MHz, level –90 dBm at RF-connector.

Trace2: With wider time scaling both monitoring and own RX bursts are seen, 1st burst (shorter) is monitoring and 2nd burst (longer) is own RX burst.

Trace1: External LNA VCC supply voltage at burst mode, input level –90 dBm. Measured from testpoint LNA_VCC.

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Figure 10: RX I&Q, phase difference 90 deg between signals.

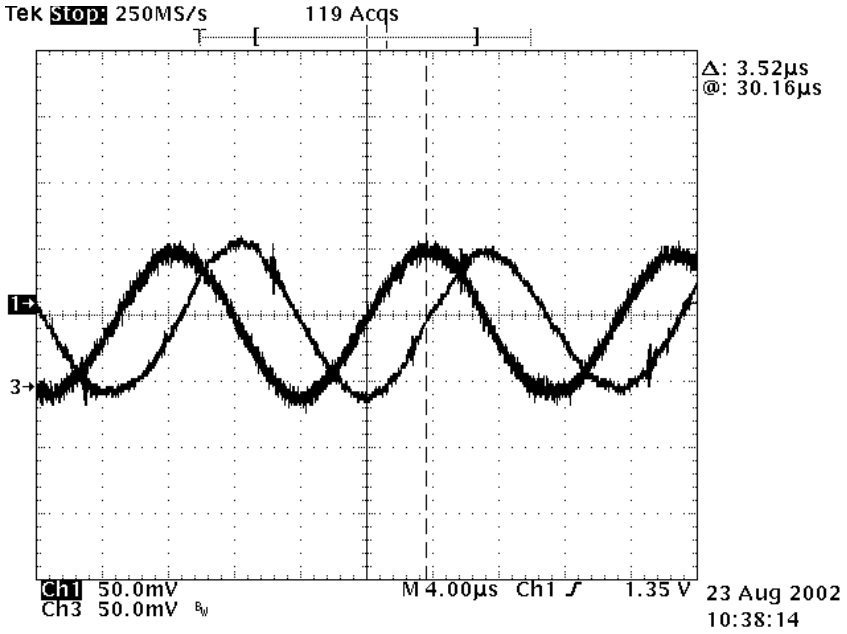

Figure 10, "RX I&Q, phase difference 90 deg between signals.," on page 17:

Detailed view of GSM900 continuous mode RX I and Q signals measured from testpoints RXI and RXQ simultaneously.

Used channel 37, input signal 942.467 MHz, level –90 dBm at antenna port, AGC setting 12.

Phase difference should be 90 degrees between RX I and Q signals at all bands.

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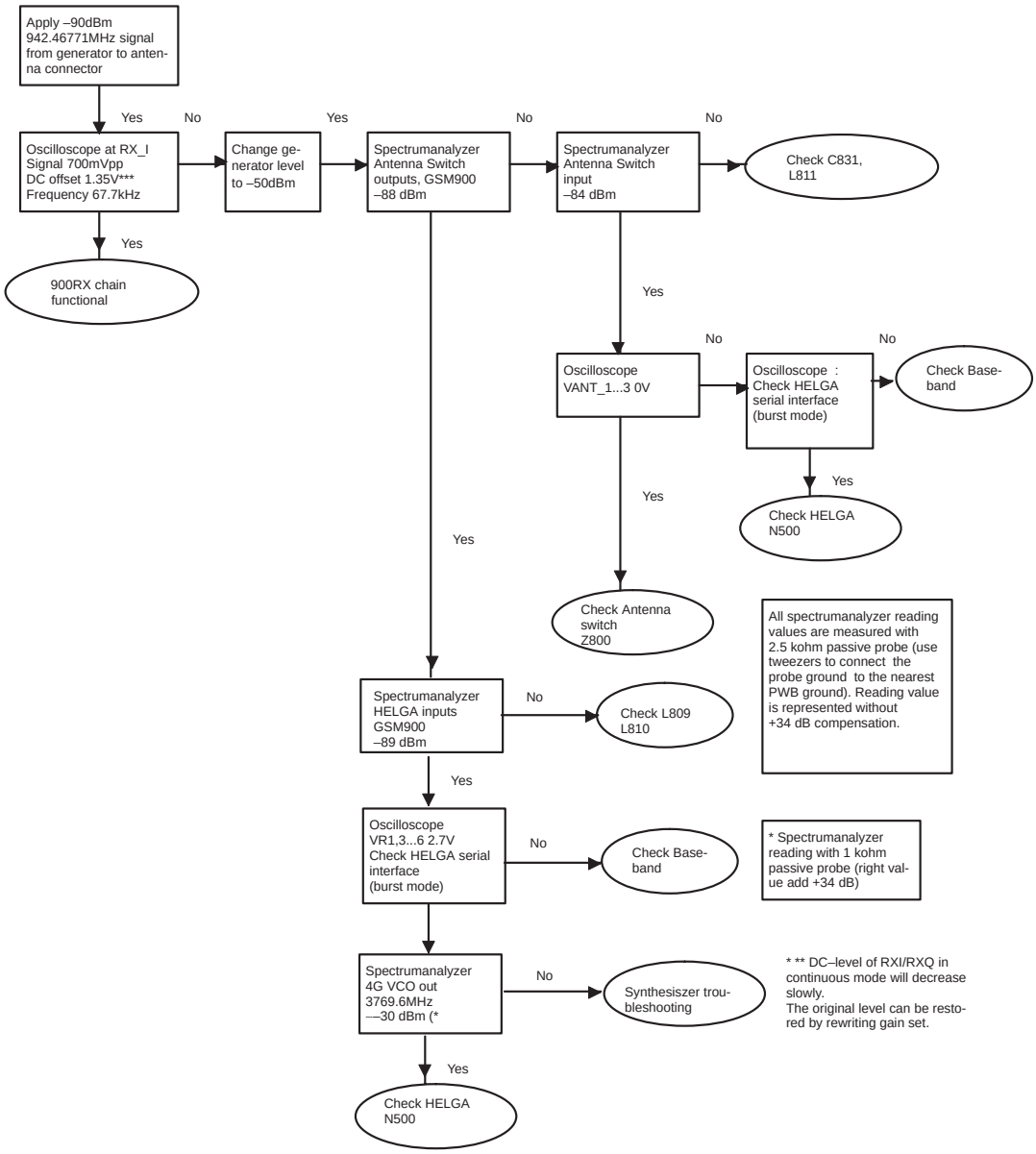
Troubleshooting diagram for GSM900 receiver

Phone in "Continuous" mode, AGC setting "12"

Figure 11: GSM900 receiver troubleshooting


Apply –90dBm 942.46771MHz signal from generator to antenna connector
Yes
No
Oscilloscope at RX_I Signal 700mVpp DC offset 1.35V*** Frequency 67.7kHz
Change generator level to –50dBm
Yes
No
Spectrumanalyzer Antenna Switch outputs, GSM900 –88 dBm
No
Spectrumanalyzer Antenna Switch input –84 dBm
Check C831, L811
Yes
900RX chain functional
Yes
Oscilloscope VANT_1...3 0V
No
Oscilloscope : Check HELGA serial interface (burst mode)
No
Check Base-band
Yes
Check HELGA N500
Yes
Check Antenna switch Z800
Yes
Spectrumanalyzer HELGA inputs GSM900 –89 dBm
No
Check L809 L810
Yes
Oscilloscope VR1,3...6 2.7V Check HELGA serial interface (burst mode)
No
Check Base-band
Spectrumanalyzer 4G VCO out 3769.6MHz —30 dBm (*
No
Synthesiszer troubleshooting
Yes
Check HELGA N500
All spectrumanalyzer reading values are measured with 2.5 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +34 dB compensation.
* Spectrumanalyzer reading with 1 kohm passive probe (right value add +34 dB)
* ** DC–level of RXI/RXQ in continuous mode will decrease slowly.
The original level can be restored by rewriting gain set.

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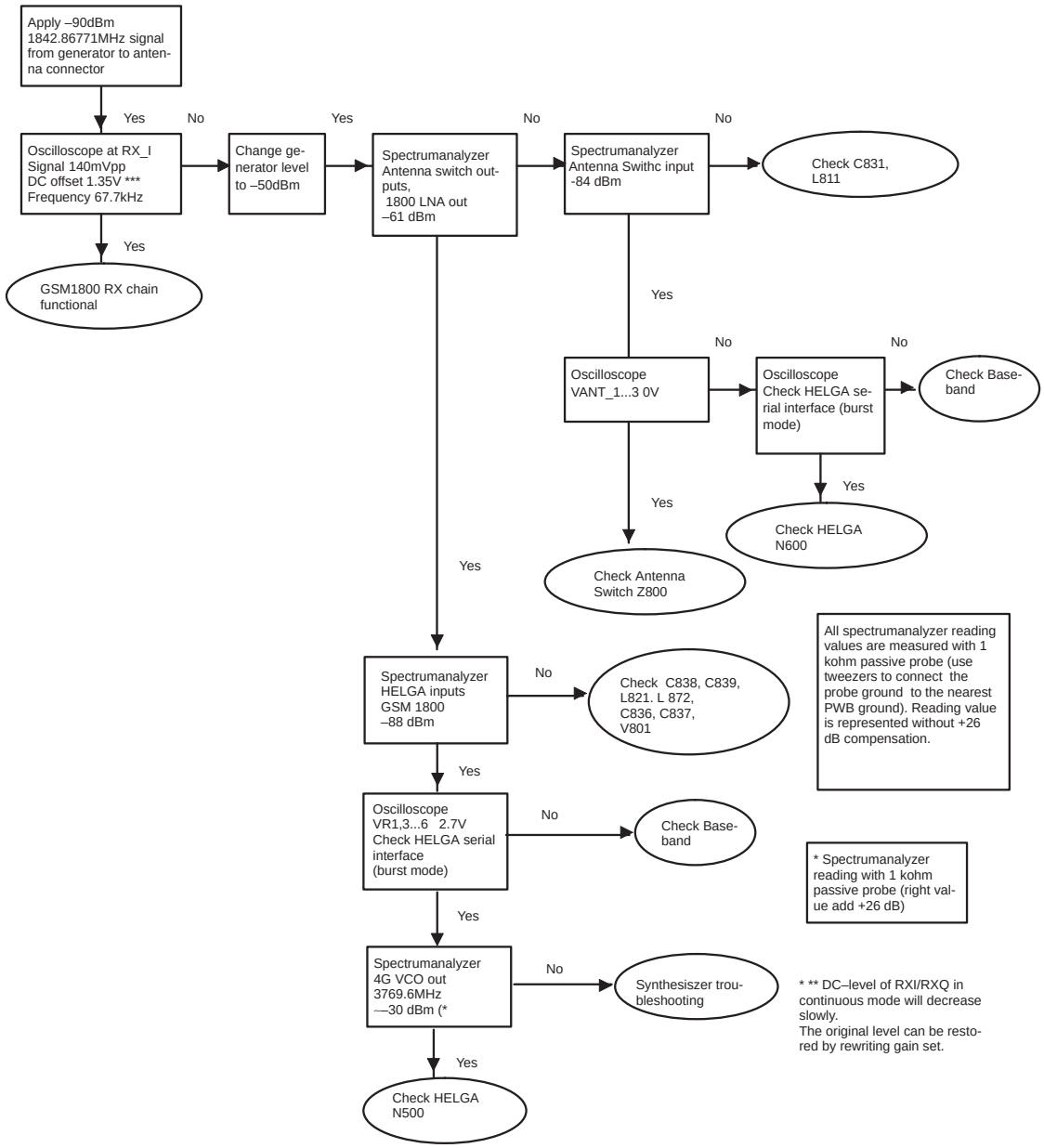
Troubleshooting diagram for GSM1800 receiver

Phone in "Continuous" mode, AGC setting "12

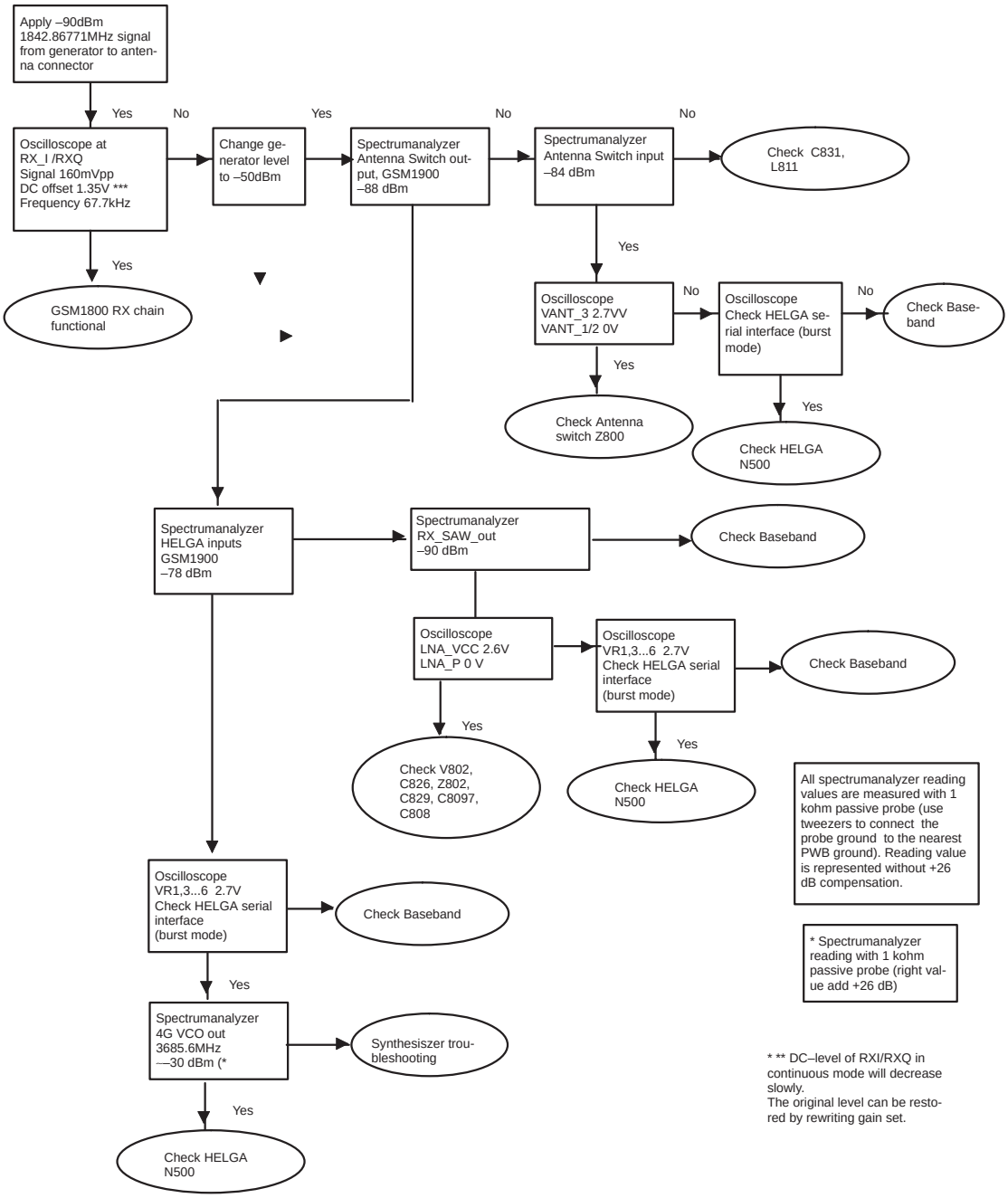
Figure 12: GSM1800 receiver troubleshooting


Apply –90dBm 1842.86771MHz signal from generator to antenna connector
Yes
No
Oscilloscope at RX_I Signal 140mVpp DC offset 1.35V *** Frequency 67.7kHz
Change generator level to –50dBm
Yes
Spectrumanalyzer Antenna switch outputs, 1800 LNA out –61 dBm
No
Spectrumanalyzer Antenna Swithc input -84 dBm
No
Check C831, L811
Yes
GSM1800 RX chain functional
Yes
Oscilloscope VANT_1...3 0V
No
Oscilloscope Check HELGA serial interface (burst mode)
No
Check Baseband
Yes
Check HELGA N600
Yes
Check Antenna Switch Z800
Yes
Spectrumanalyzer HELGA inputs GSM 1800 –88 dBm
No
Check C838, C839, L821. L 872, C836, C837, V801
Yes
Oscilloscope VR1,3...6 2.7V Check HELGA serial interface (burst mode)
No
Check Baseband
Yes
Spectrumanalyzer 4G VCO out 3769.6MHz —30 dBm (*
No
Synthesiszer troubleshooting
Yes
Check HELGA N500
All spectrumanalyzer reading values are measured with 1 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +26 dB compensation.
* Spectrumanalyzer reading with 1 kohm passive probe (right value add +26 dB)
* ** DC–level of RXI/RXQ in continuous mode will decrease slowly.
The original level can be restored by rewriting gain set.

Troubleshooting diagram for GSM1900 receiver

Phone in "Continuous" mode, AGC setting "12

Figure 13: GSM1900 receiver troubleshooting


Apply –90dBm 1842.86771MHz signal from generator to antenna connector
Yes
No
Oscilloscope at RX_I /RXQ Signal 160mVpp DC offset 1.35V *** Frequency 67.7kHz
Change generator level to –50dBm
Yes
No
Spectrumanalyzer Antenna Switch output, GSM1900 –88 dBm
Spectrumanalyzer Antenna Switch input –84 dBm
No
Check C831, L811
Yes
GSM1800 RX chain functional
Yes
Oscilloscope VANT_3 2.7VV VANT_1/2 0V
No
Oscilloscope Check HELGA serial interface (burst mode)
No
Check Baseband
Yes
Check Antenna switch Z800
Yes
Check HELGA N500
Spectrumanalyzer HELGA inputs GSM1900 –78 dBm
Spectrumanalyzer RX_SAW_out –90 dBm
Check Baseband
Oscilloscope LNA_VCC 2.6V LNA_P 0 V
Oscilloscope VR1,3...6 2.7V Check HELGA serial interface (burst mode)
Check Baseband
Yes
Check V802, C826, Z802, C829, C8097, C808
Yes
Check HELGA N500
All spectrumanalyzer reading values are measured with 1 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +26 dB compensation.
Oscilloscope VR1,3...6 2.7V Check HELGA serial interface (burst mode)
Check Baseband
* Spectrumanalyzer reading with 1 kohm passive probe (right value add +26 dB)
Yes
Spectrumanalyzer 4G VCO out 3685.6MHz —30 dBm (*
Synthesiszer troubleshooting
* ** DC–level of RXI/RXQ in continuous mode will decrease slowly.
The original level can be restored by rewriting gain set.
Yes
Check HELGA N500

Synthesizer

General instructions for synthesizer troubleshooting

Connect test jig to computer with DAU9S cable or to FPS-8 Flash Prommer with XCS-4 modular cable.

Make sure that you have PKD-1 dongle connected to computers parallel port.

Connect DC power supply or FPS-8 to module test jig with PCS-1 cable.

Set the DC supply voltage to 3.9V and set the jumper connector on test jig to "bypass" position.

Set the phone module to test jig and start Phoenix service sofware

Initialize connection to phone. (use FBUS driver when using DAU9S and COMBOX driver when using FPS-8)

Select product from the menu

File -> Choose product -> RM-37

From toolbar set operating mode to "Local"

Activate RF controls window from the menu

Maintenance -> Testing -> RF Controls

From the RF controls window

- Select band "GSM900", "GSM 1800" or "GSM1900" (Default = "GSM900")

- Set Active unit to "Rx" (Default = "Rx")

- Set Operation mode to "Continuous" (Default = "Burst")

- Set Rx/Tx channel to 37 on GSM900 band, 700 on GSM1800 band, 661 on GSM1900 band (Defaults)

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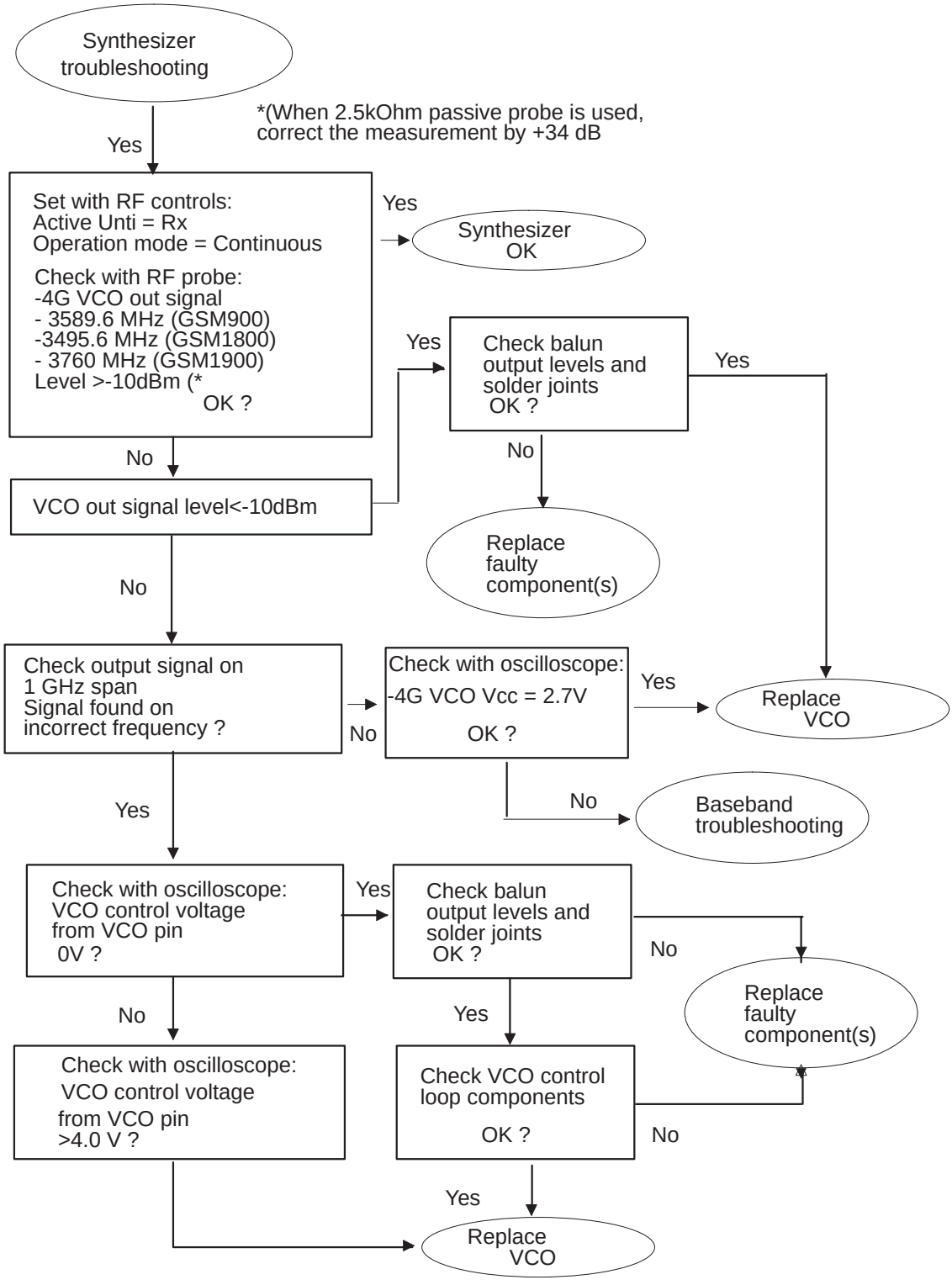
Synthesizer troubleshooting diagram

Figure 14:



Pictures of synthesizer signals

Figure 15: 26MHz at G501 pin out

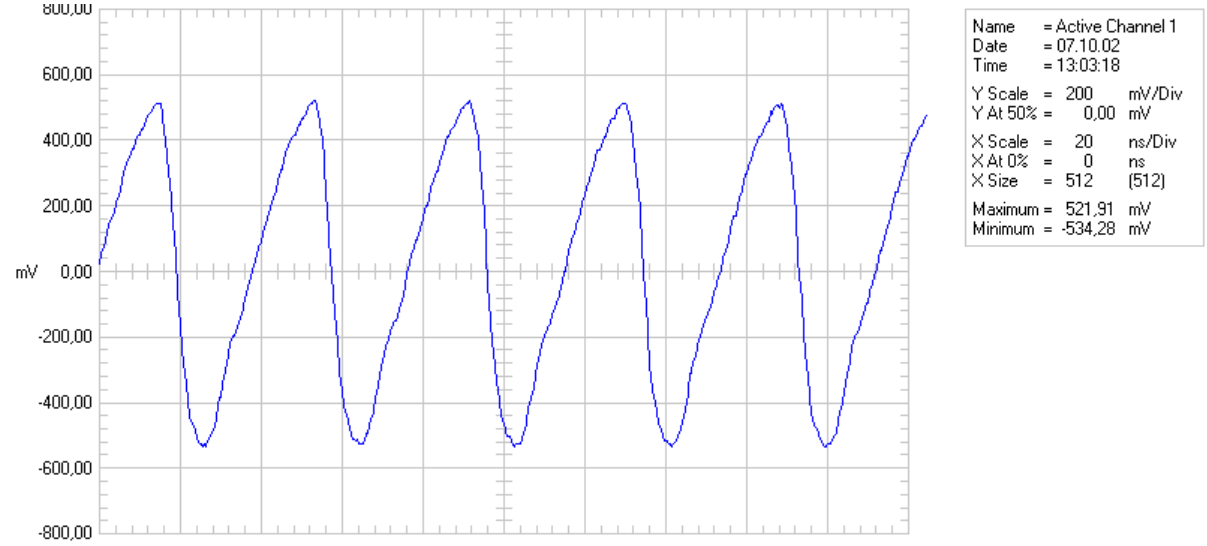


Figure 16: 26MHz RFCLK at R420/C420

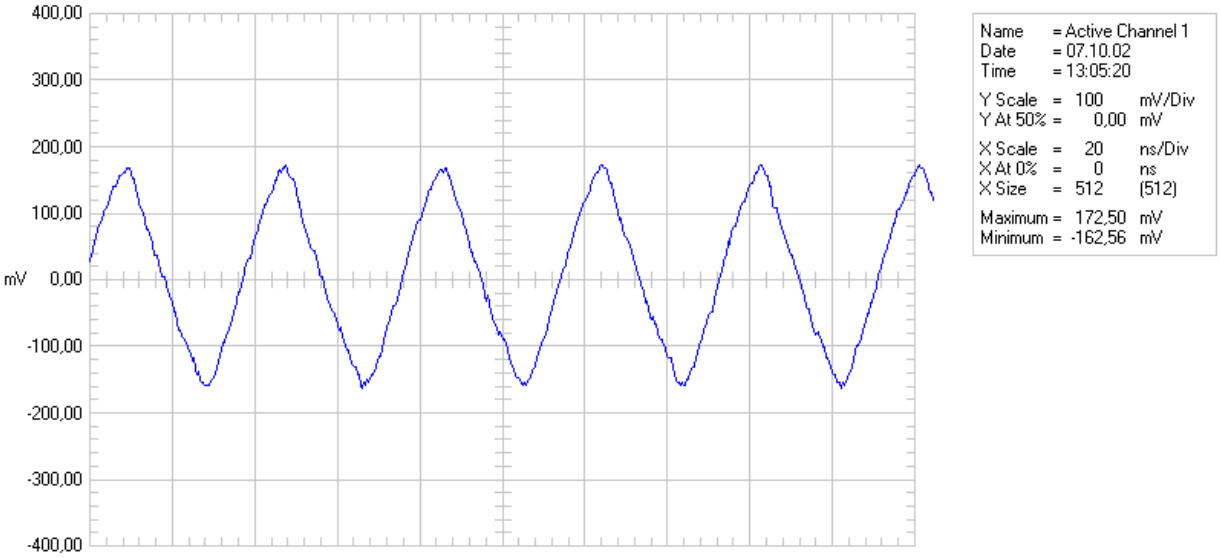


Figure 17: 1800 TX, channel 512, burst mode

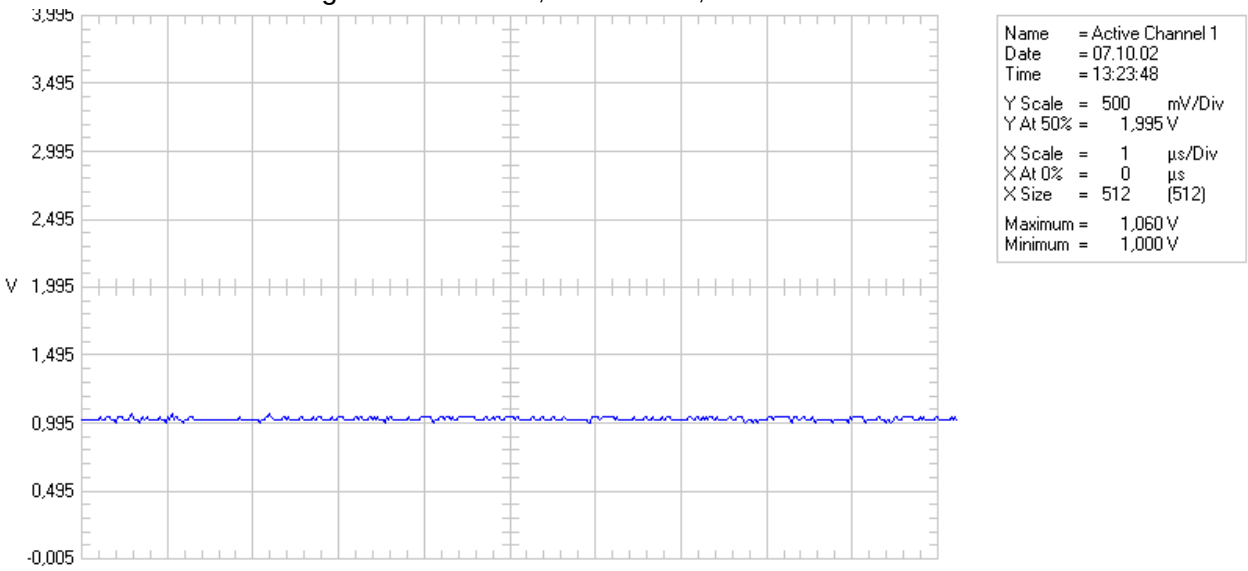


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Figure 18: 1900 RX, channel 810, continuous mode

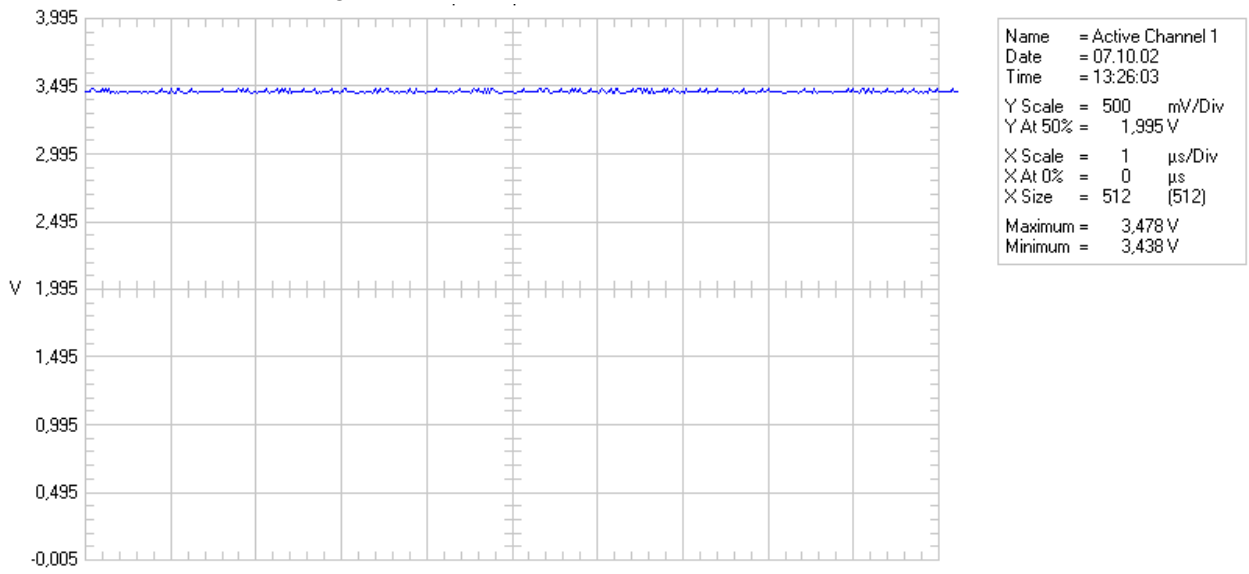
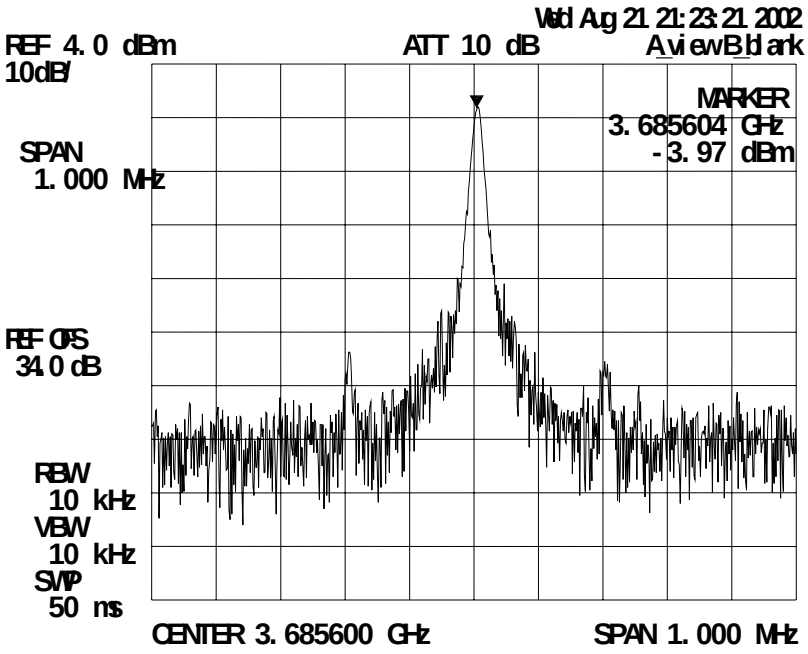


Figure 19: VCO output, 1800 band, RX on, continuous output



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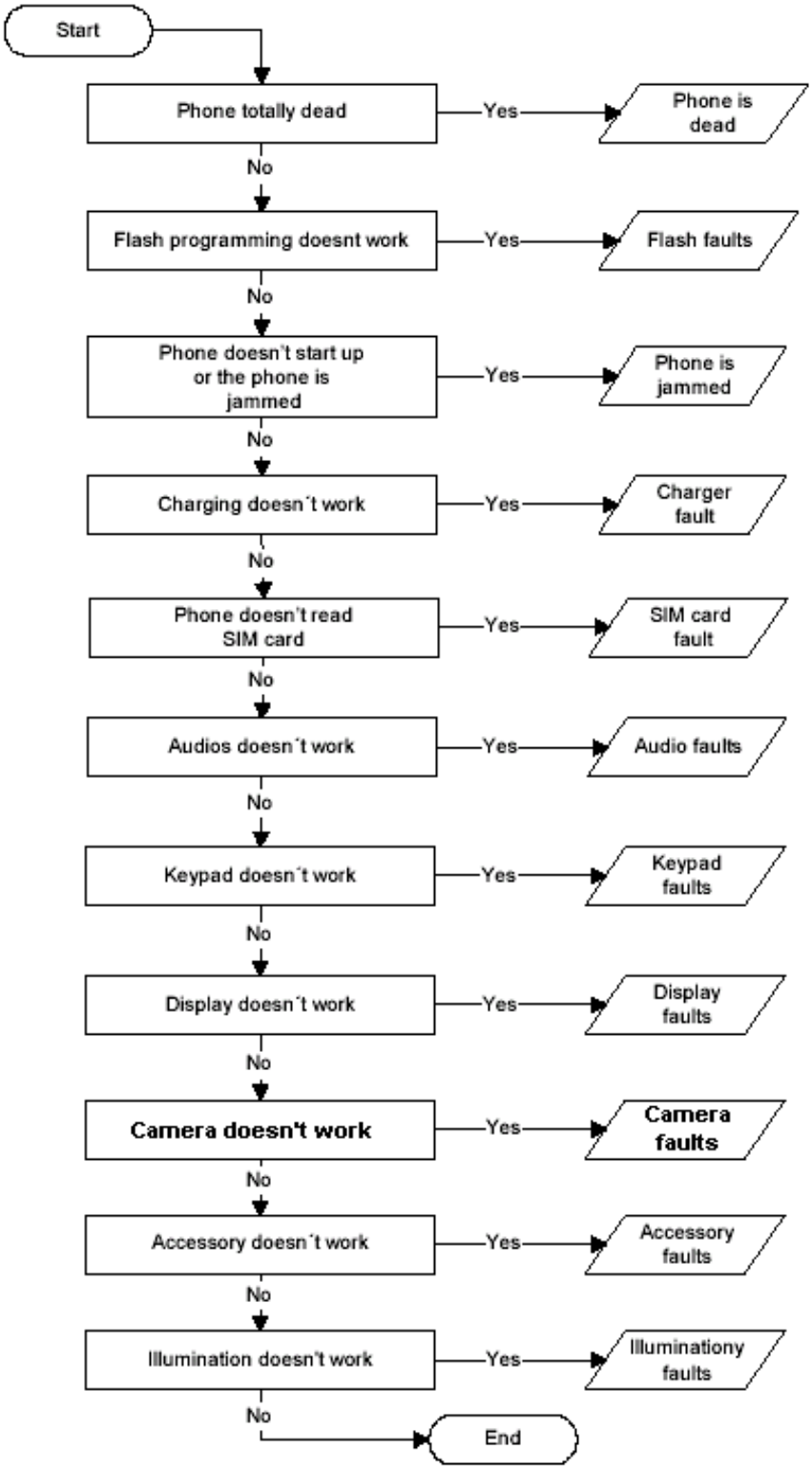
Baseband troubleshooting

The following diagrams describe baseband troubleshooting.

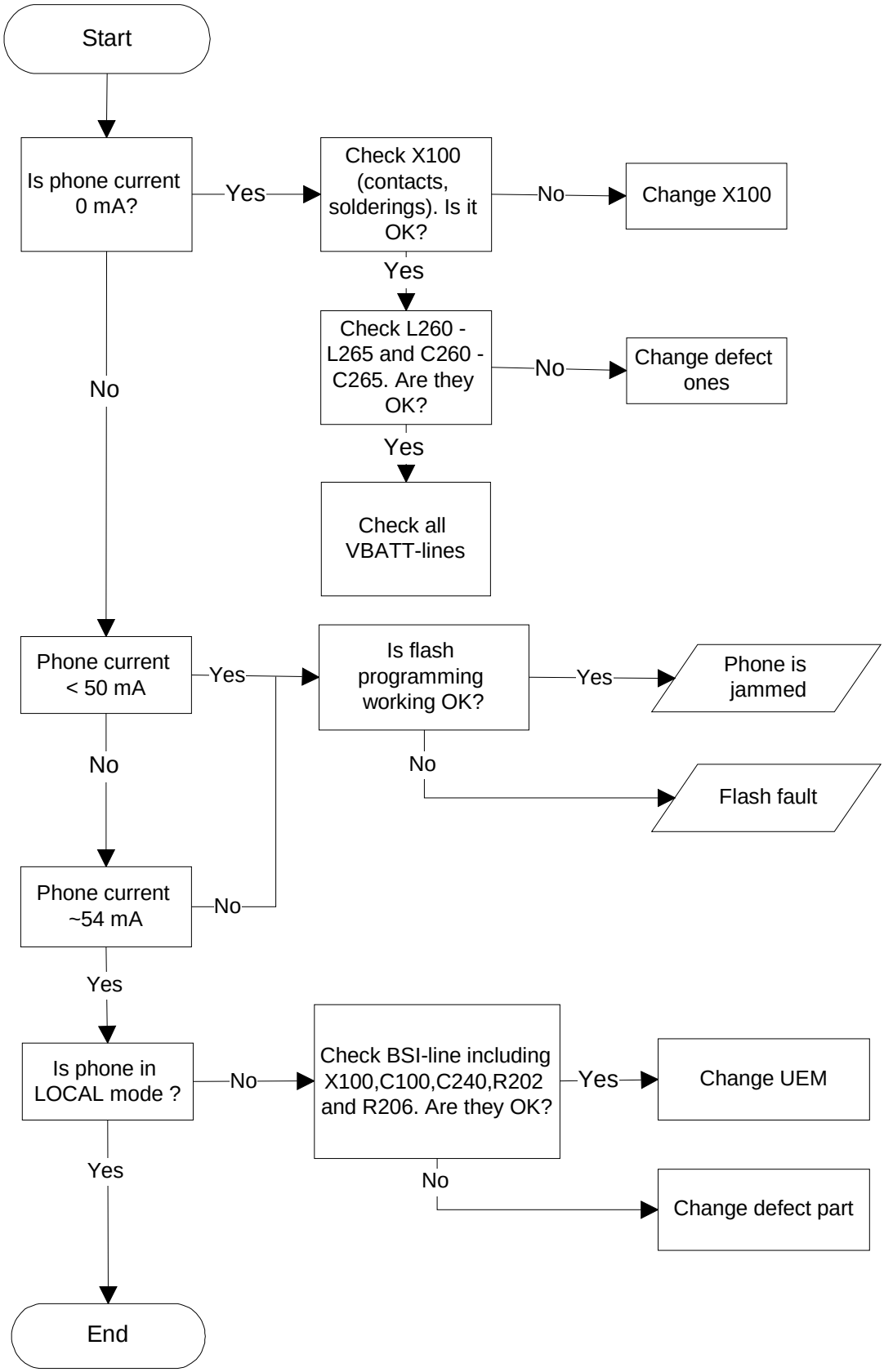
Main Troubleshooting Diagram

Figure 20: Baseband general troubleshooting



Phone is dead

Figure 21: Dead phone troubleshooting



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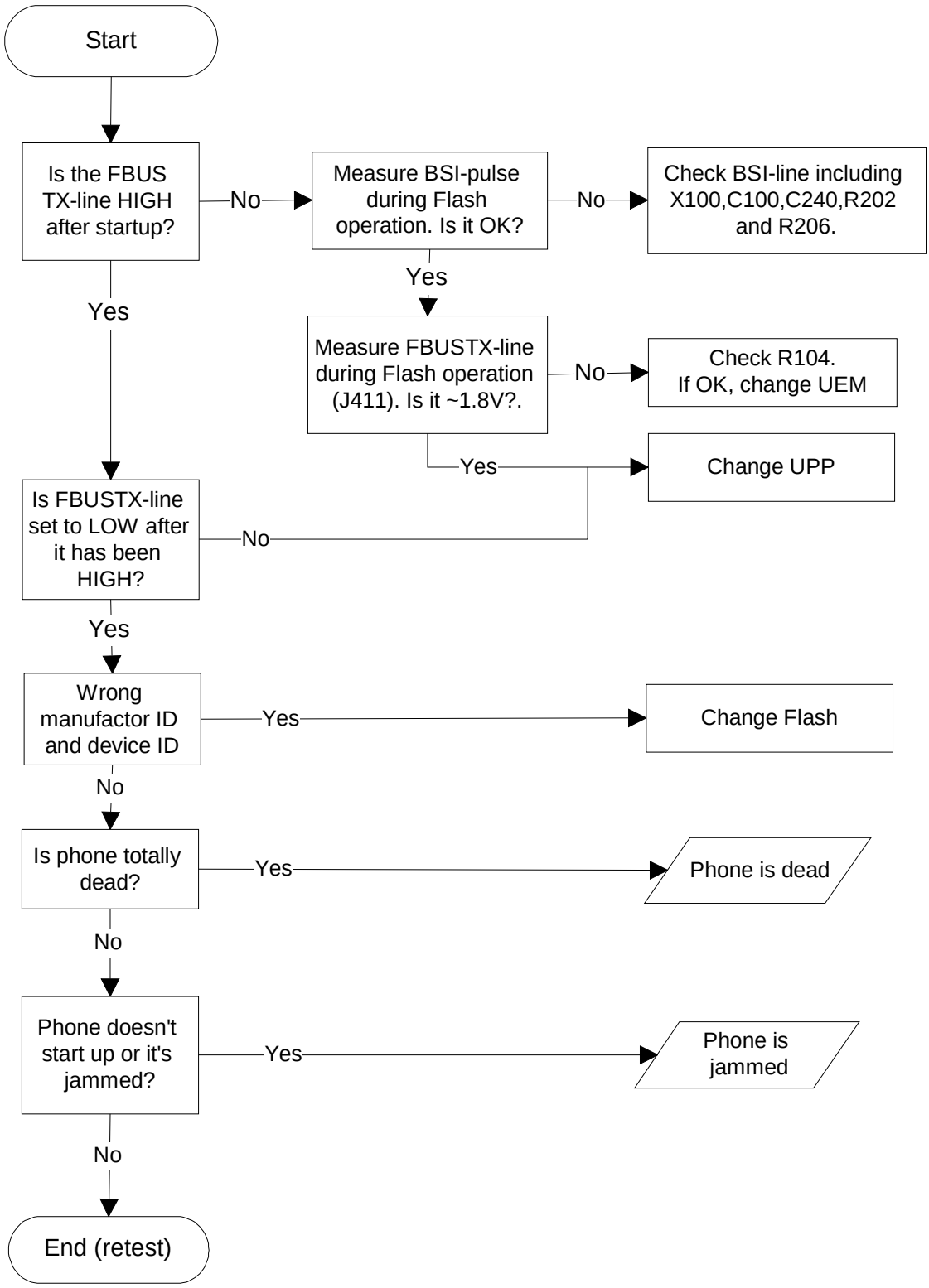
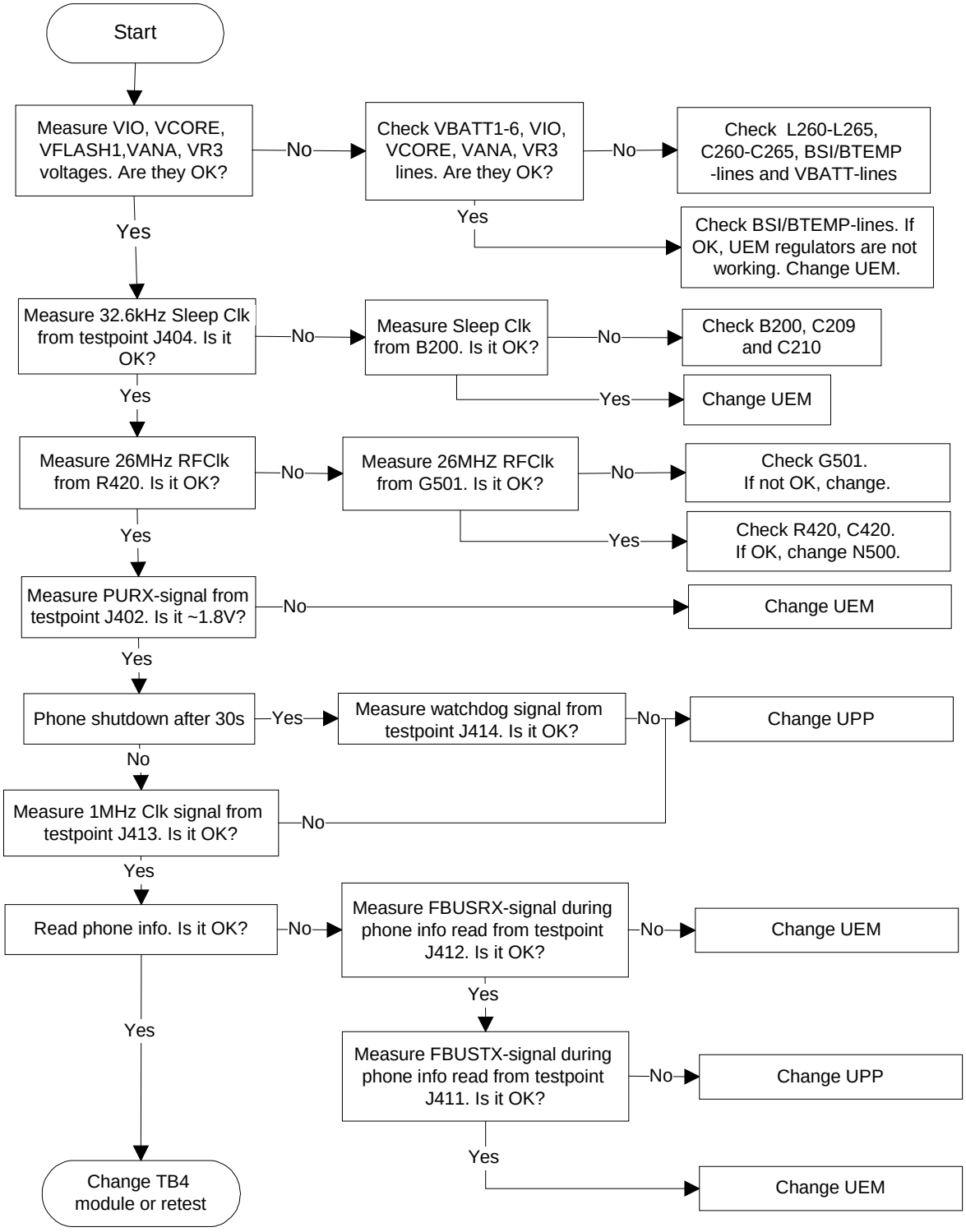
Flash Programming Fault

Figure 22: Flash programming troubleshooting



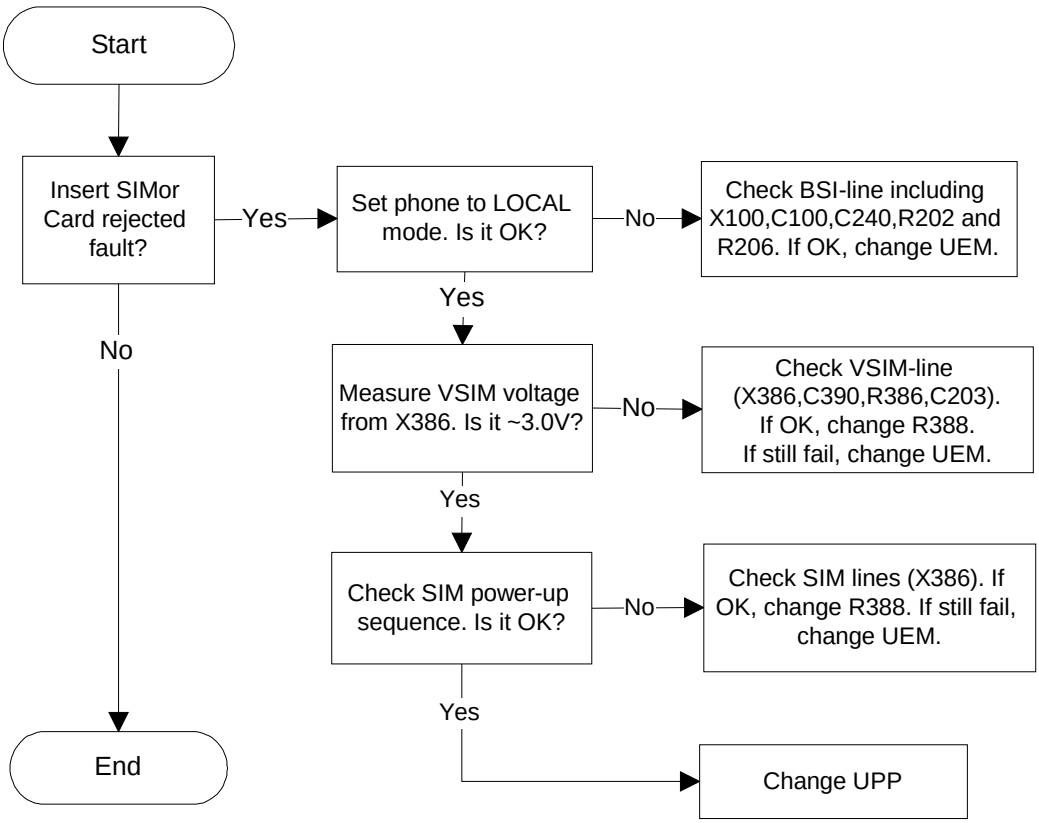
Phone is jammed

Figure 23: Jammed phone troubleshooting



SIM card fault (Insert SIM / Card rejected)

Figure 24: SIM card troubleshooting


Start
Insert SIMor Card rejected fault?
Yes
Set phone to LOCAL mode. Is it OK?
No
Check BSI-line including X100,C100,C240,R202 and R206. If OK, change UEM.
Yes
No
Measure VSIM voltage from X386. Is it ~3.0V?
No
Check VSIM-line (X386,C390,R386,C203). If OK, change R388. If still fail, change UEM.
Yes
Check SIM power-up sequence. Is it OK?
No
Check SIM lines (X386). If OK, change R388. If still fail, change UEM.
Yes
End
Change UPP

Keypad Fault

Figure 25: Keypad troubleshooting 1

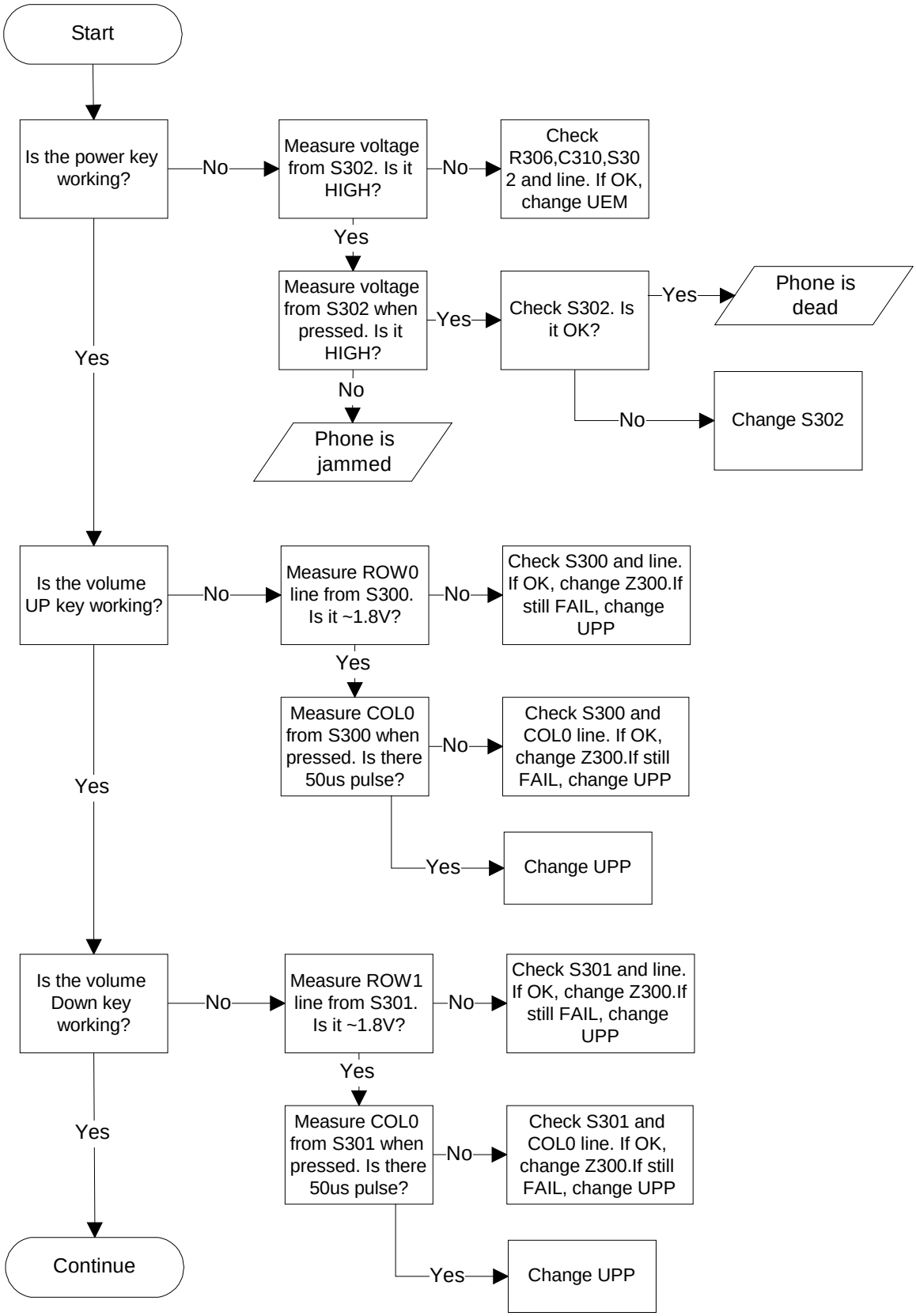
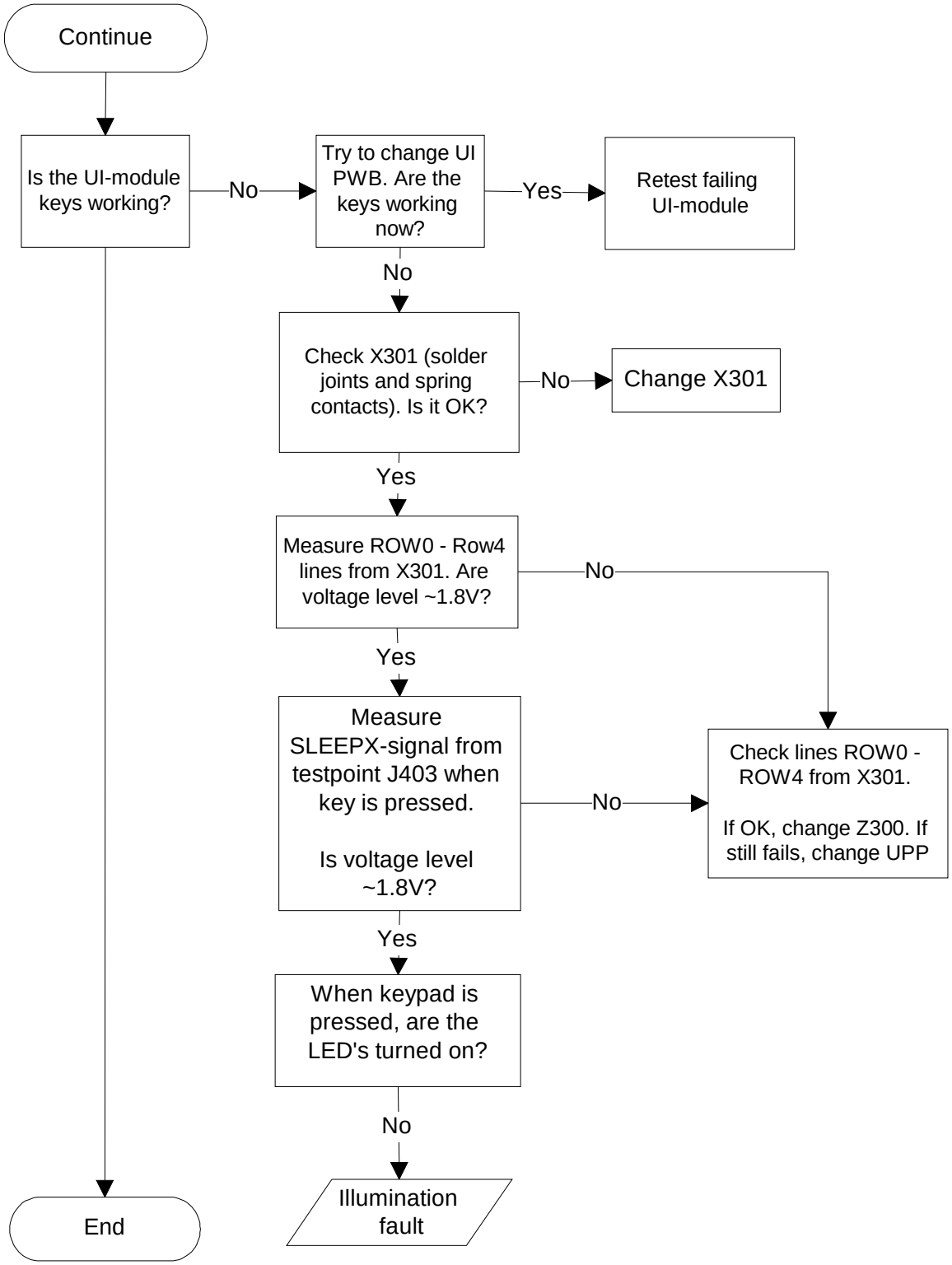
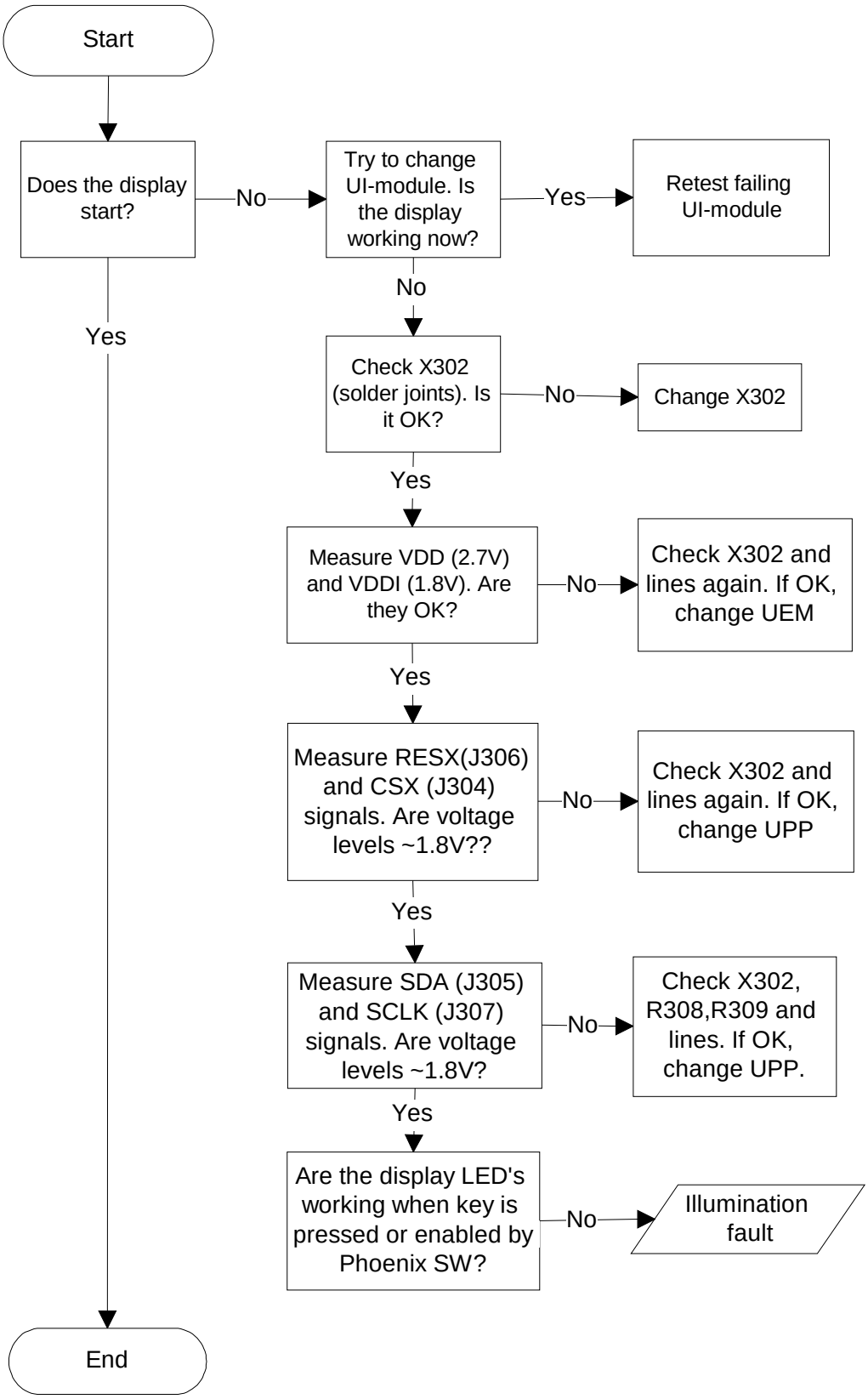

Start
Is the power key working?
No
Measure voltage from S302. Is it HIGH?
No
Check R306,C310,S302 and line. If OK, change UEM
Yes
Measure voltage from S302 when pressed. Is it HIGH?
Yes
Check S302. Is it OK?
Yes
Phone is dead
No
Change S302
No
Phone is jammed
Yes
Is the volume UP key working?
No
Measure ROW0 line from S300. Is it ~1.8V?
No
Check S300 and line. If OK, change Z300.If still FAIL, change UPP
Yes
Measure COL0 from S300 when pressed. Is there 50us pulse?
No
Check S300 and COL0 line. If OK, change Z300.If still FAIL, change UPP
Yes
Change UPP
Yes
Is the volume Down key working?
No
Measure ROW1 line from S301. Is it ~1.8V?
No
Check S301 and line. If OK, change Z300.If still FAIL, change UPP
Yes
Measure COL0 from S301 when pressed. Is there 50us pulse?
No
Check S301 and COL0 line. If OK, change Z300.If still FAIL, change UPP
Yes
Change UPP
Yes
Continue

Figure 26: Keypad troubleshooting 2



Display Fault

Figure 27: Display troubleshooting


Start
Does the display start?
No
Try to change UI-module. Is the display working now?
Yes
Retest failing UI-module
No
Yes
Check X302 (solder joints). Is it OK?
No
Change X302
Yes
Measure VDD (2.7V) and VDDI (1.8V). Are they OK?
No
Check X302 and lines again. If OK, change UEM
Yes
Measure RESX(J306) and CSX (J304) signals. Are voltage levels ~1.8V??
No
Check X302 and lines again. If OK, change UPP
Yes
Measure SDA (J305) and SCLK (J307) signals. Are voltage levels ~1.8V?
No
Check X302, R308,R309 and lines. If OK, change UPP.
Yes
Are the display LED's working when key is pressed or enabled by Phoenix SW?
No
Illumination fault
End

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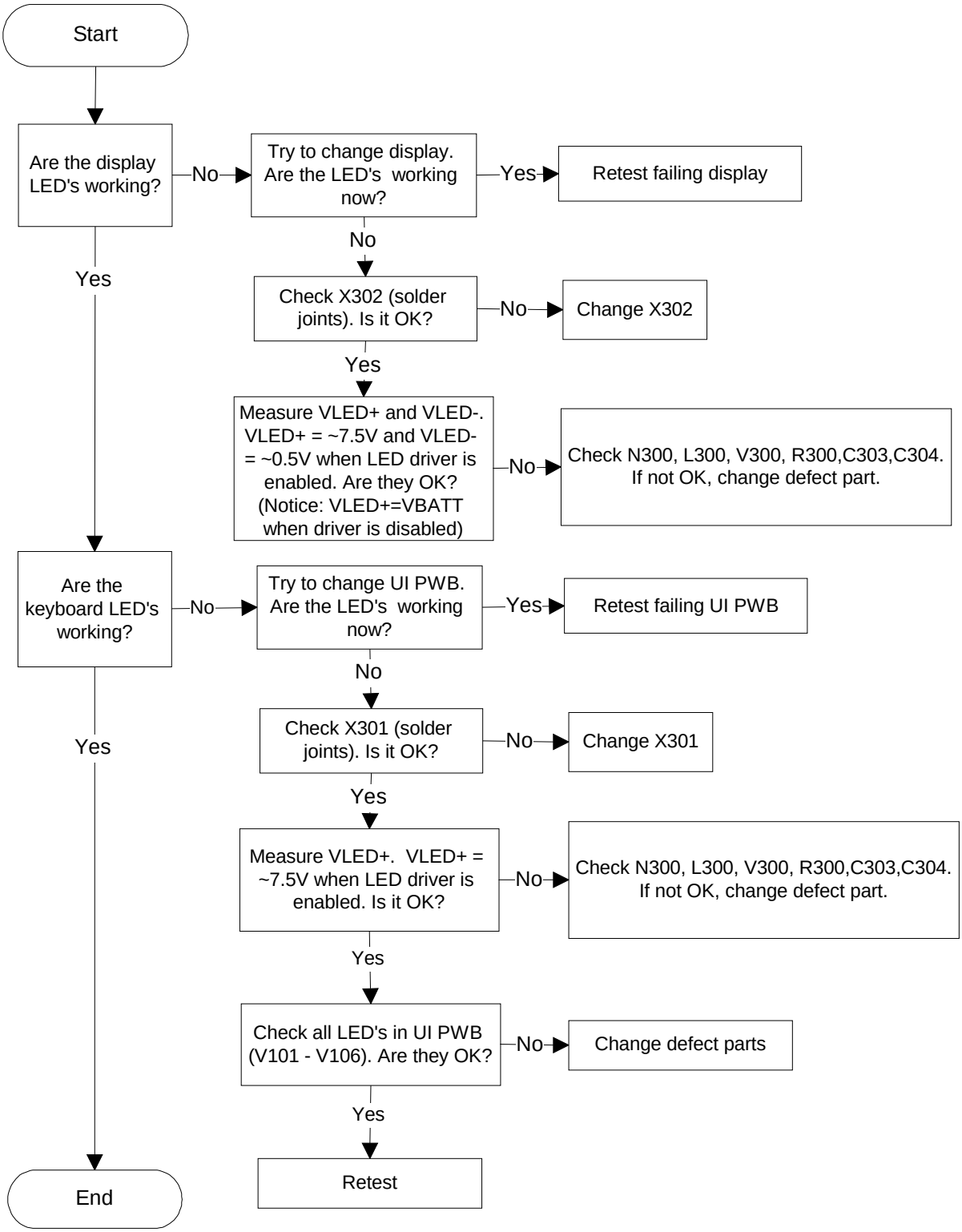
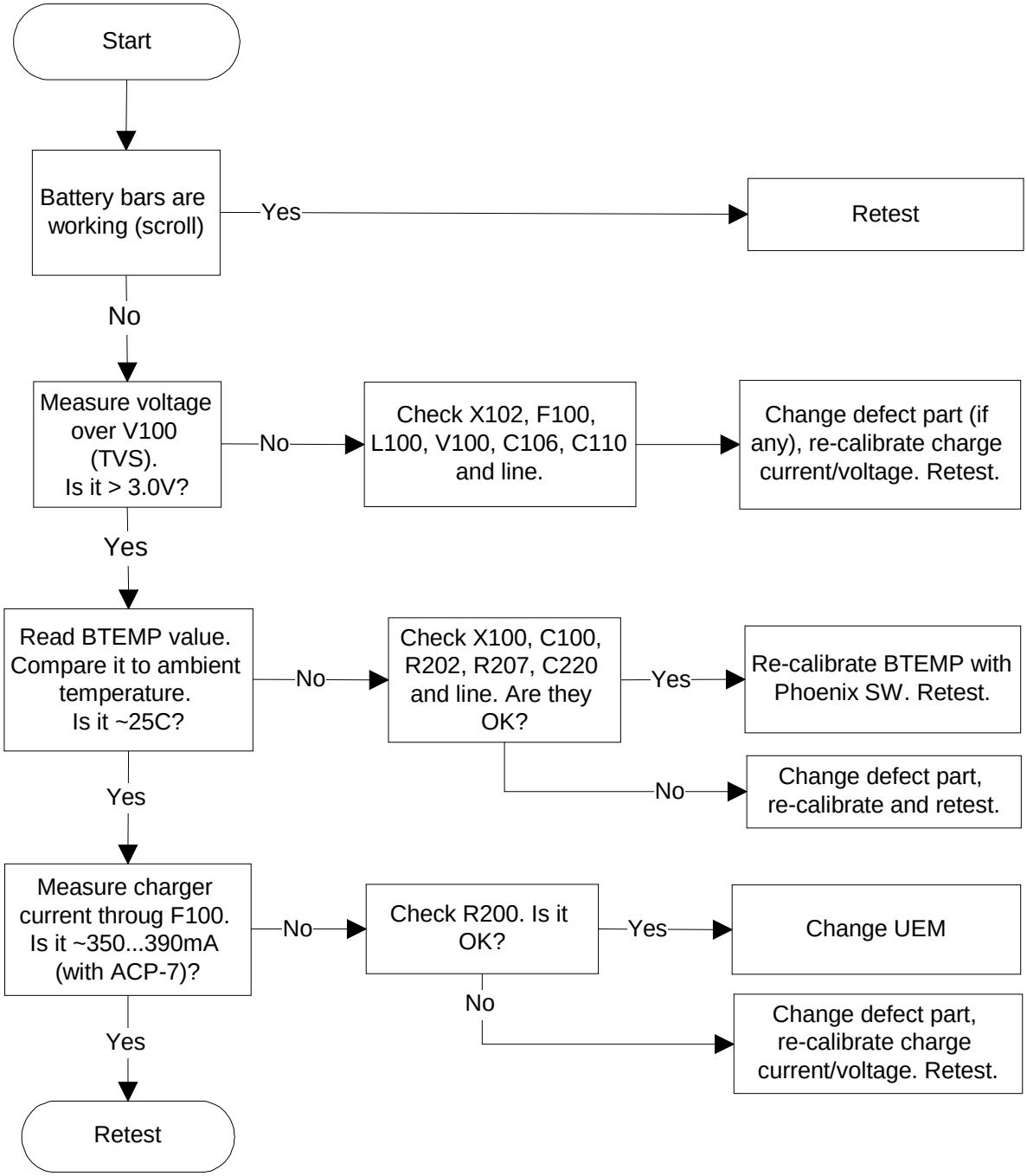
Illumination fault

Figure 28: Backlight troubleshooting


Start
Are the display LED's working?
No
Try to change display. Are the LED's working now?
Yes
Retest failing display
No
Yes
Check X302 (solder joints). Is it OK?
No
Change X302
Yes
Measure VLED+ and VLED-. VLED+ = ~7.5V and VLED- = ~0.5V when LED driver is enabled. Are they OK? (Notice: VLED+=VBATT when driver is disabled)
No
Check N300, L300, V300, R300,C303,C304. If not OK, change defect part.
Are the keyboard LED's working?
No
Try to change UI PWB. Are the LED's working now?
Yes
Retest failing UI PWB
No
Yes
Check X301 (solder joints). Is it OK?
No
Change X301
Yes
Measure VLED+. VLED+ = ~7.5V when LED driver is enabled. Is it OK?
No
Check N300, L300, V300, R300,C303,C304. If not OK, change defect part.
Yes
Check all LED's in UI PWB (V101 - V106). Are they OK?
No
Change defect parts
Yes
Retest
End

Charger Fault

Figure 29: Charging troubleshooting



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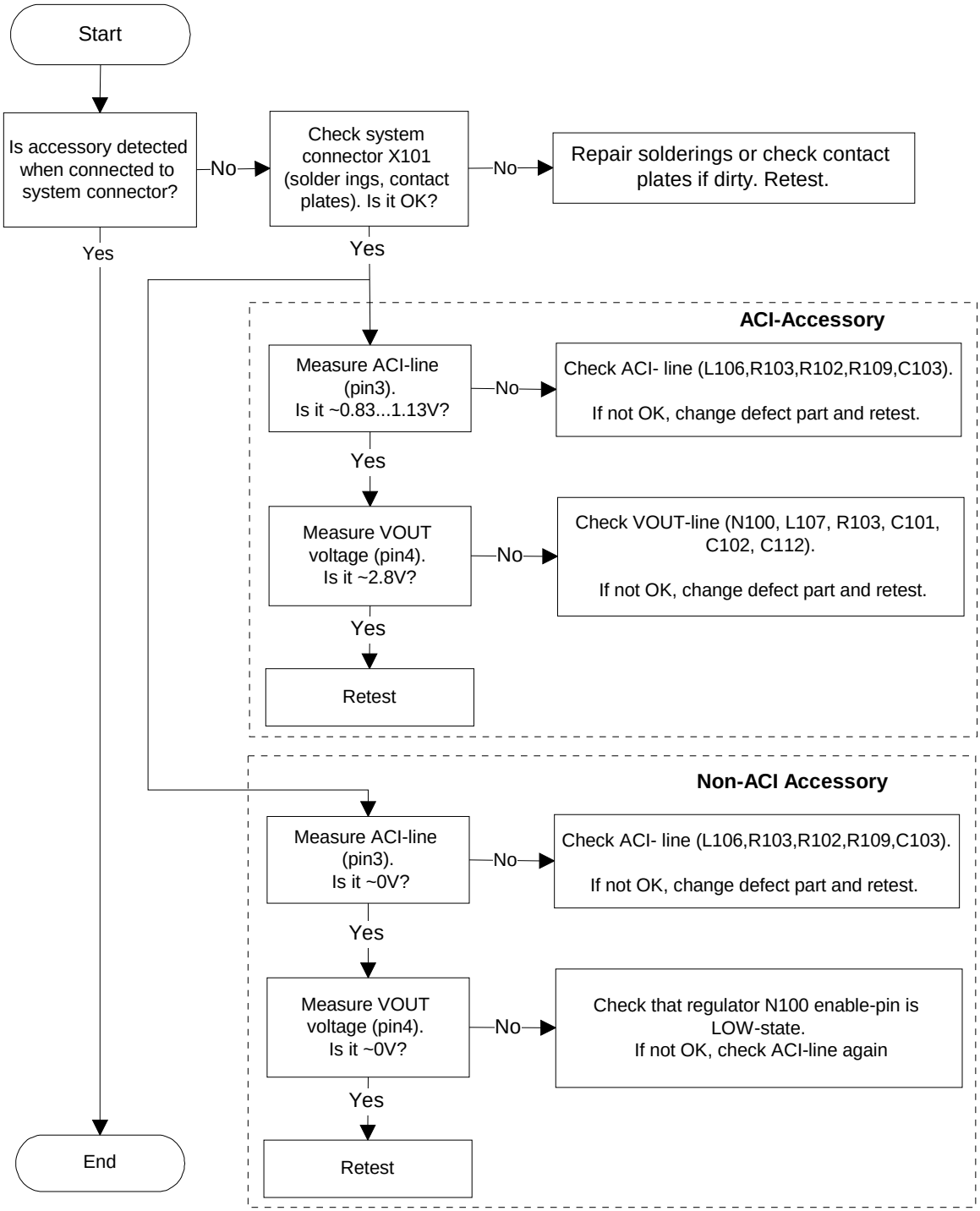
Accessory Fault

Figure 30: Accessory troubleshooting



Camera Troubleshooting

Figure 31: Component placement

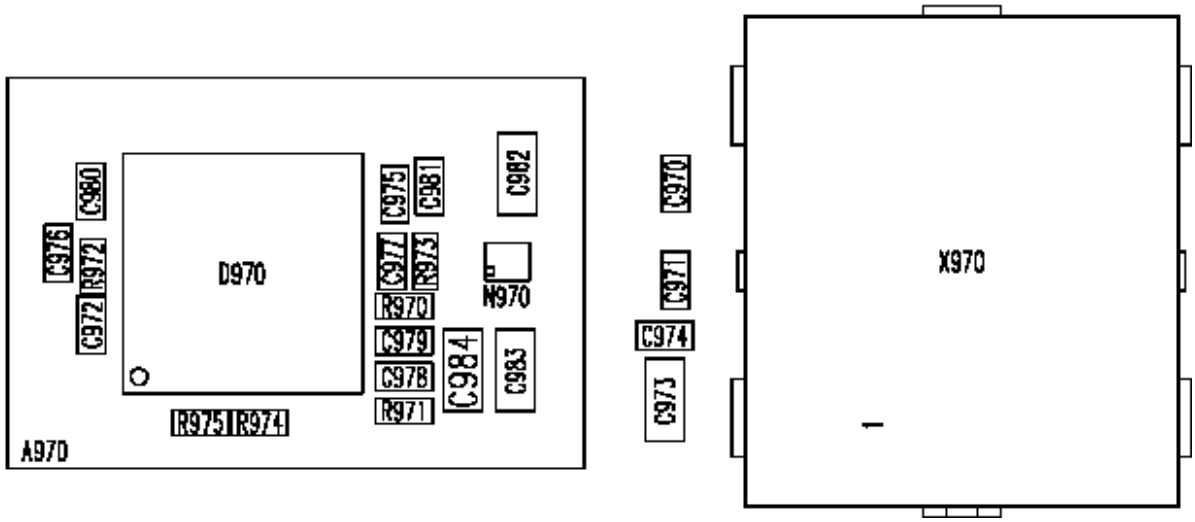
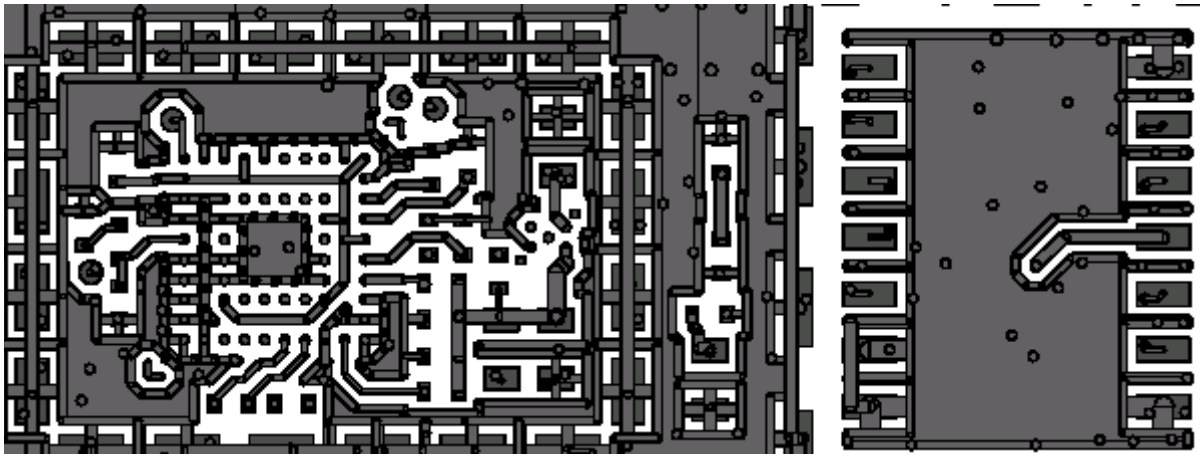


Figure 32: Trace layout



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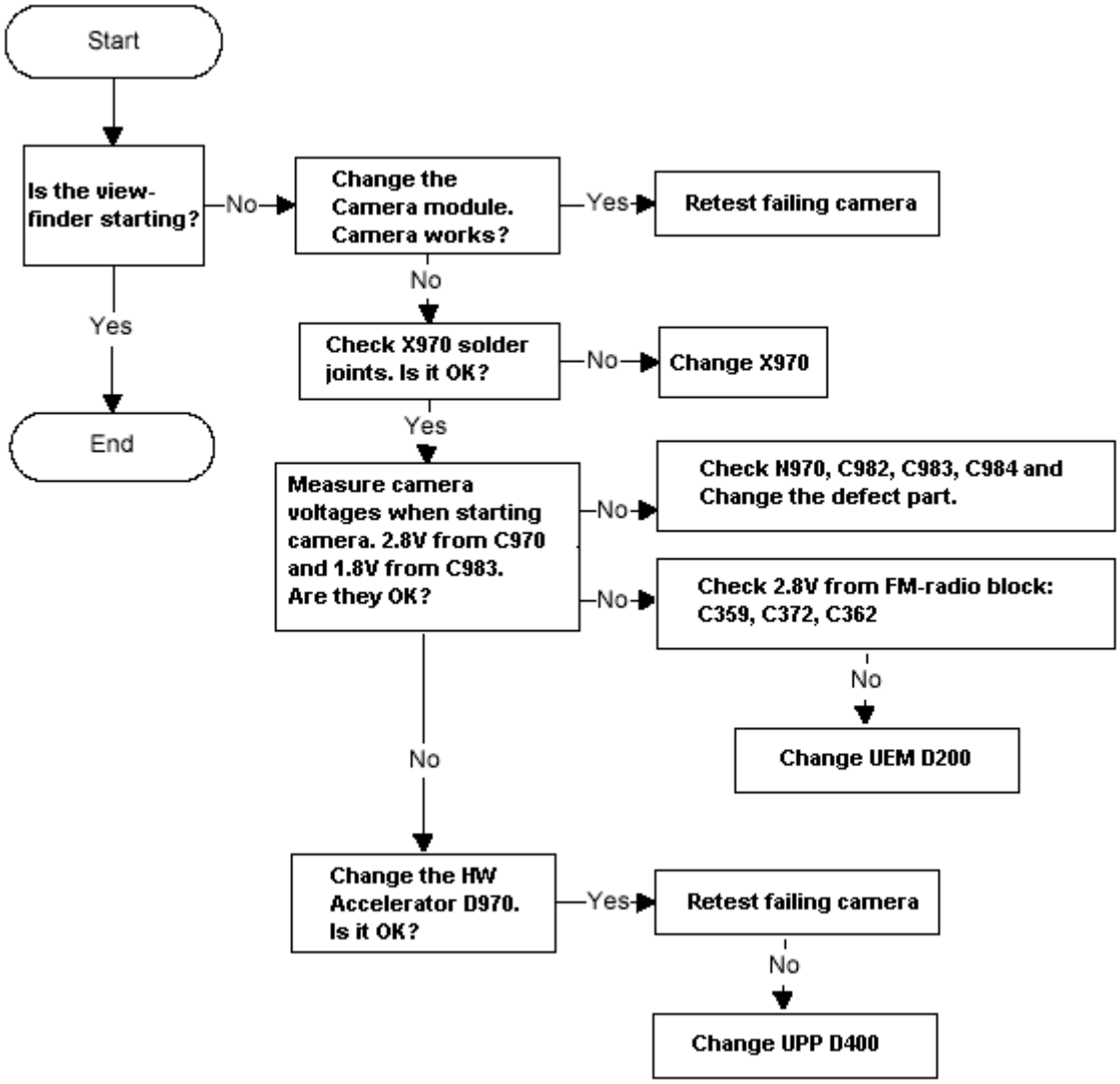
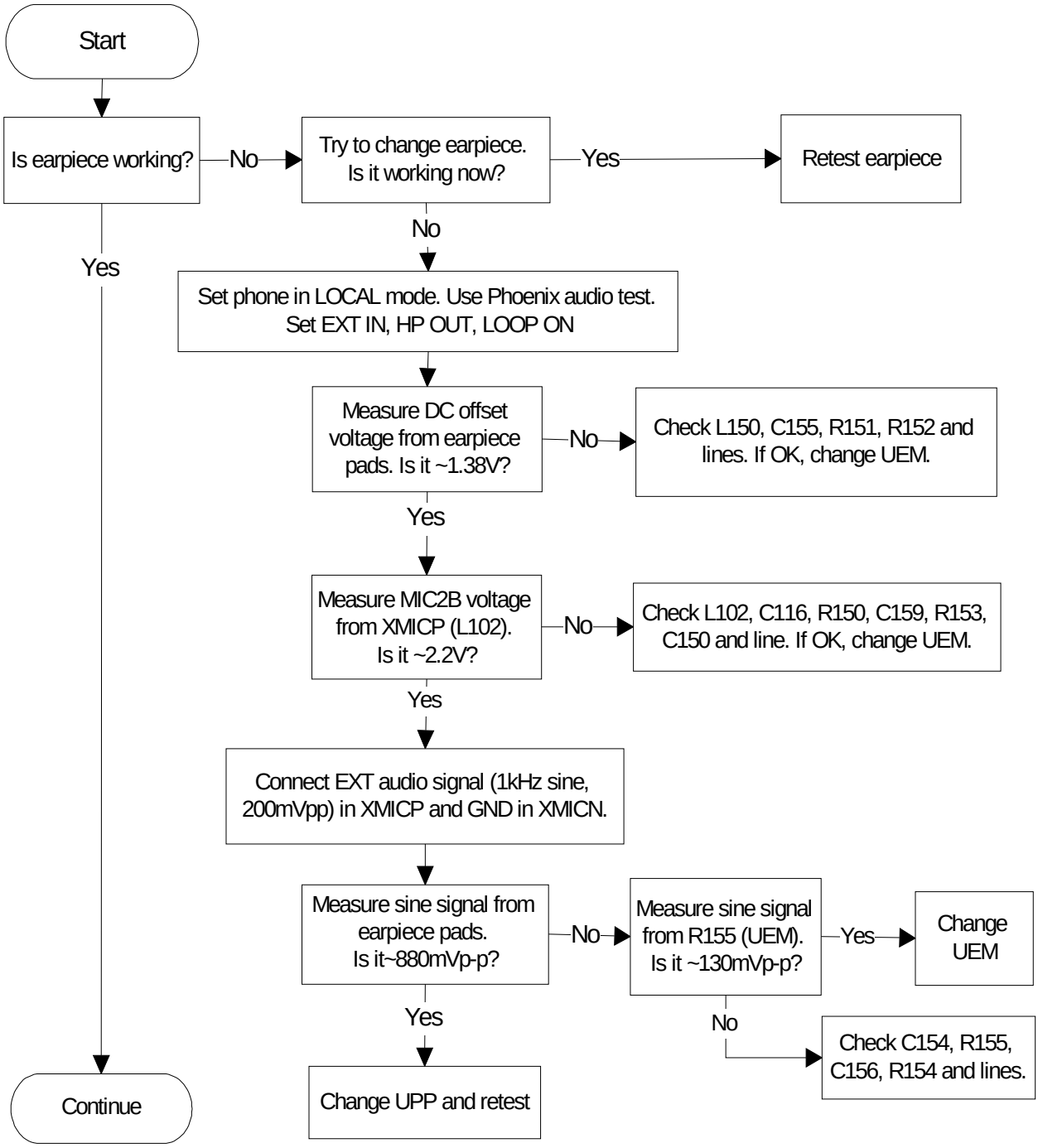
Camera Fault

Figure 33: Camera troubleshooting diagram



Audio Fault

Figure 34: Audio troubleshooting


Start
Is earpiece working?
No
Try to change earpiece. Is it working now?
Yes
Retest earpiece
No
Yes
Set phone in LOCAL mode. Use Phoenix audio test. Set EXT IN, HP OUT, LOOP ON
Measure DC offset voltage from earpiece pads. Is it ~1.38V?
No
Check L150, C155, R151, R152 and lines. If OK, change UEM.
Yes
Measure MIC2B voltage from XMICP (L102). Is it ~2.2V?
No
Check L102, C116, R150, C159, R153, C150 and line. If OK, change UEM.
Yes
Connect EXT audio signal (1kHz sine, 200mVpp) in XMICP and GND in XMICN.
Measure sine signal from earpiece pads. Is it~880mVp-p?
No
Measure sine signal from R155 (UEM). Is it ~130mVp-p?
Yes
Change UEM
Yes
No
Check C154, R155, C156, R154 and lines.
Continue
Change UPP and retest

FM Radio troubleshooting

FM Radio component layout

Figure 35: Component placement

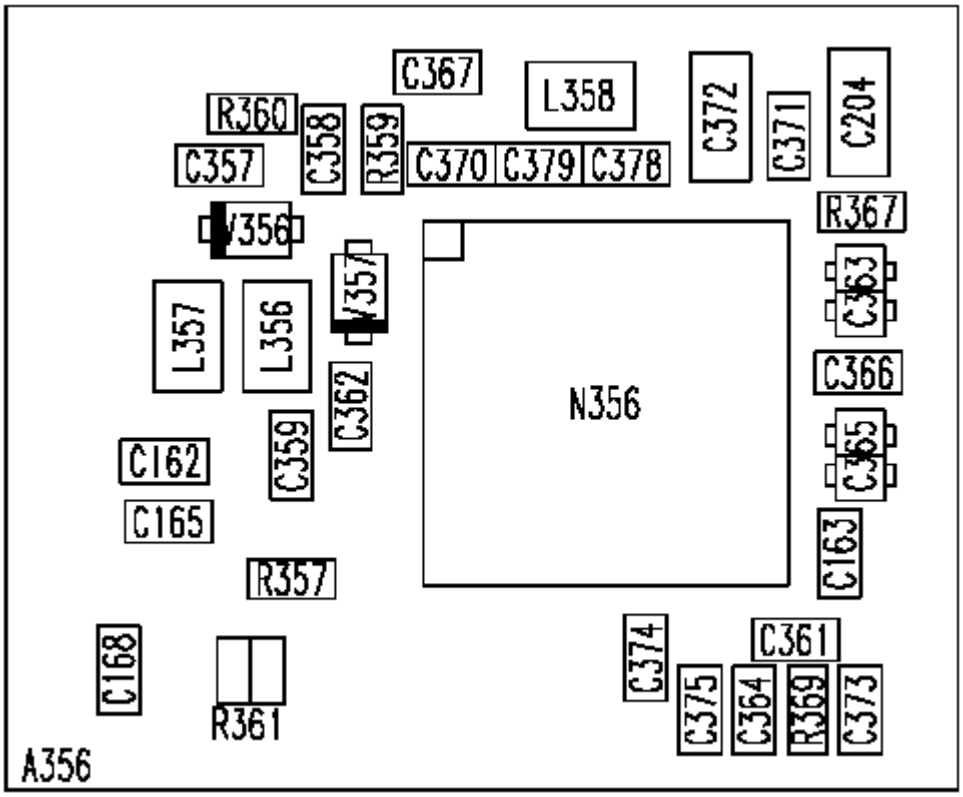


Figure 36: Trace layout.

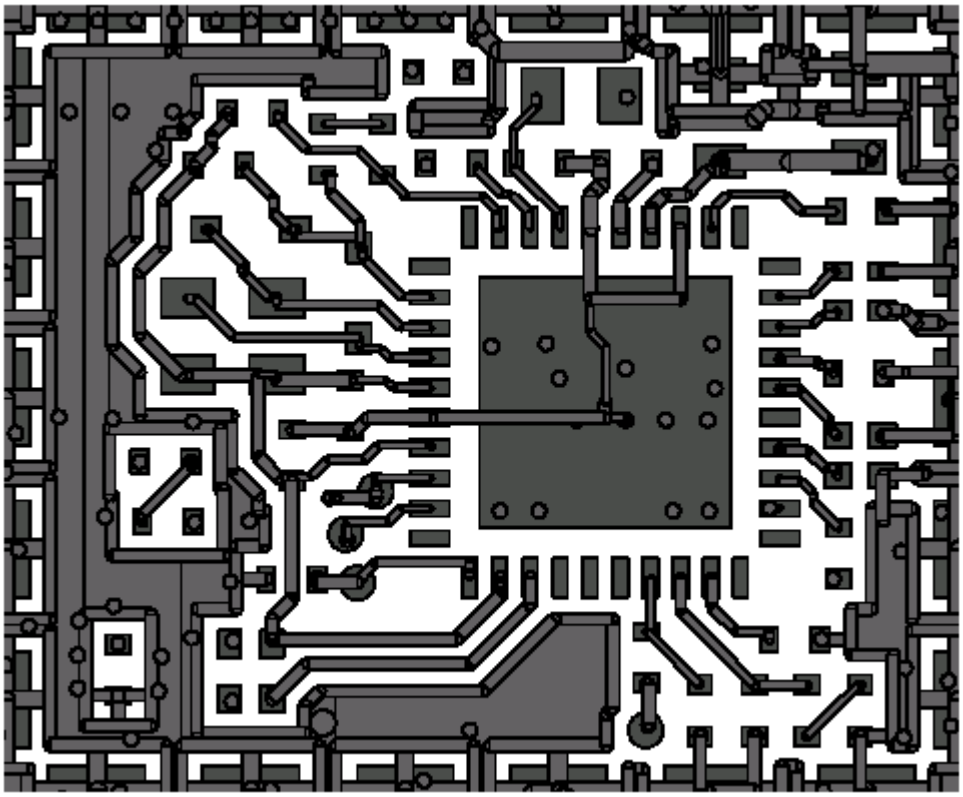


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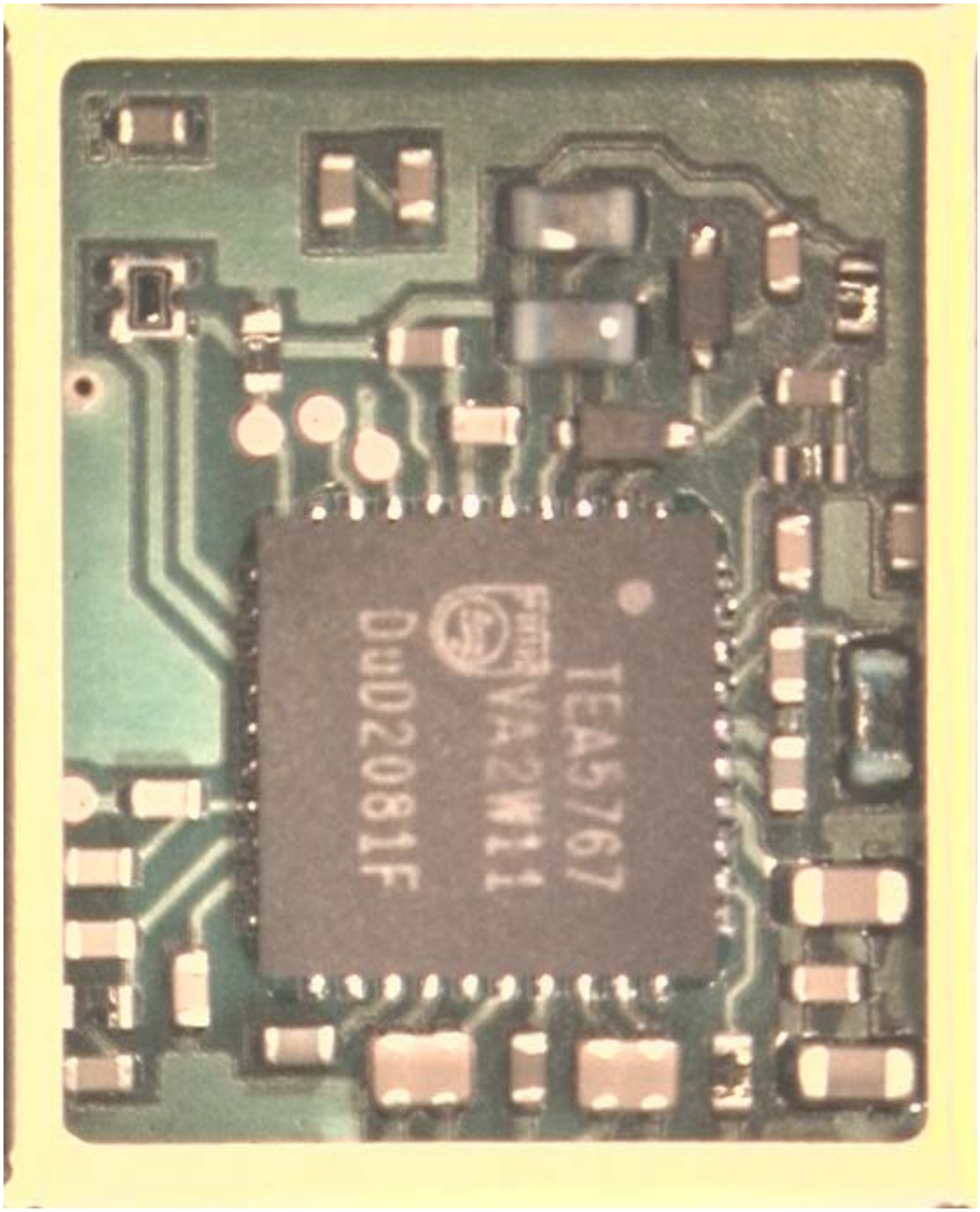
Figure 37: FM radio block layout.



Components L103, L104, L105, C107, C108, C109, C117, C162, C163, R164, R165, R166 and R167 are not shown in the picture. Those components are placed in baseband section, near audio amplifier N150.

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FM Radio troubleshooting diagram

Notes to "FM Radio troubleshooting diagram"

Use 1MHz 1X probe when measuring Audio and clock signals with oscilloscope.

Use active RF probe when measuring frequencies with spectrum analyzer.

Note 1. RF test signal parameters:

- Amplitude, A, –67.0 dBm
- Carrier frequency, f_c, 98,000 MHz
- Deviation, Δf, 75 kHz
- Modulating frequency f_m, 1,000 kHz (RF generator internal)
- FM stereo, mode R=L, pilot state ON

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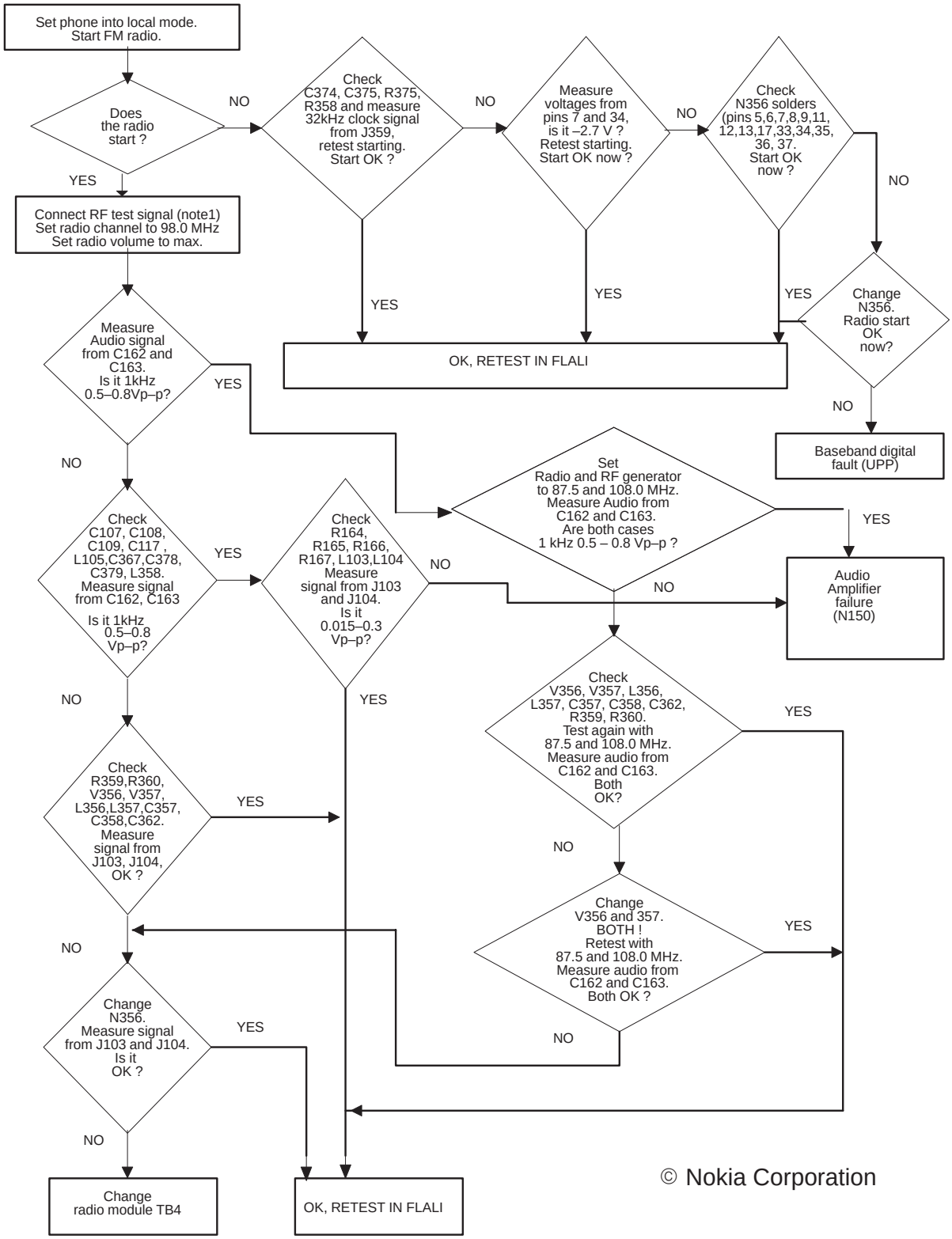
Figure 38: FM radio troubleshooting diagram


Set phone into local mode.
Start FM radio.
Does the radio start ?
NO
Check C374, C375, R375, R358 and measure 32kHz clock signal from J359, retest starting. Start OK ?
NO
Measure voltages from pins 7 and 34, is it –2.7 V ? Retest starting. Start OK now ?
NO
Check N356 solders (pins 5,6,7,8,9,11, 12,13,17,33,34,35, 36, 37. Start OK now ?
NO
YES
Connect RF test signal (note1)
Set radio channel to 98.0 MHz
Set radio volume to max.
YES
YES
YES
OK, RETEST IN FLALI
Change N356. Radio start OK now?
NO
Baseband digital fault (UPP)
Measure Audio signal from C162 and C163. Is it 1kHz 0.5–0.8Vp–p?
YES
NO
Set Radio and RF generator to 87.5 and 108.0 MHz. Measure Audio from C162 and C163. Are both cases 1 kHz 0.5 – 0.8 Vp–p ?
YES
NO
Audio Amplifier failure (N150)
Check C107, C108, C109, C117 , L105,C367,C378, C379, L358. Measure signal from C162, C163 Is it 1kHz 0.5–0.8 Vp–p?
YES
Check R164, R165, R166, R167, L103,L104 Measure signal from J103 and J104. Is it 0.015–0.3 Vp–p?
NO
YES
NO
Check V356, V357, L356, L357, C357, C358, C362, R359, R360. Test again with 87.5 and 108.0 MHz. Measure audio from C162 and C163. Both OK?
YES
NO
Check R359,R360, V356, V357, L356,L357,C357, C358,C362. Measure signal from J103, J104, OK ?
YES
Change V356 and 357. BOTH ! Retest with 87.5 and 108.0 MHz. Measure audio from C162 and C163. Both OK ?
YES
NO
NO
Change N356. Measure signal from J103 and J104. Is it OK ?
YES
NO
Change radio module TB4
OK, RETEST IN FLALI
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Diagrams of FM radio signals

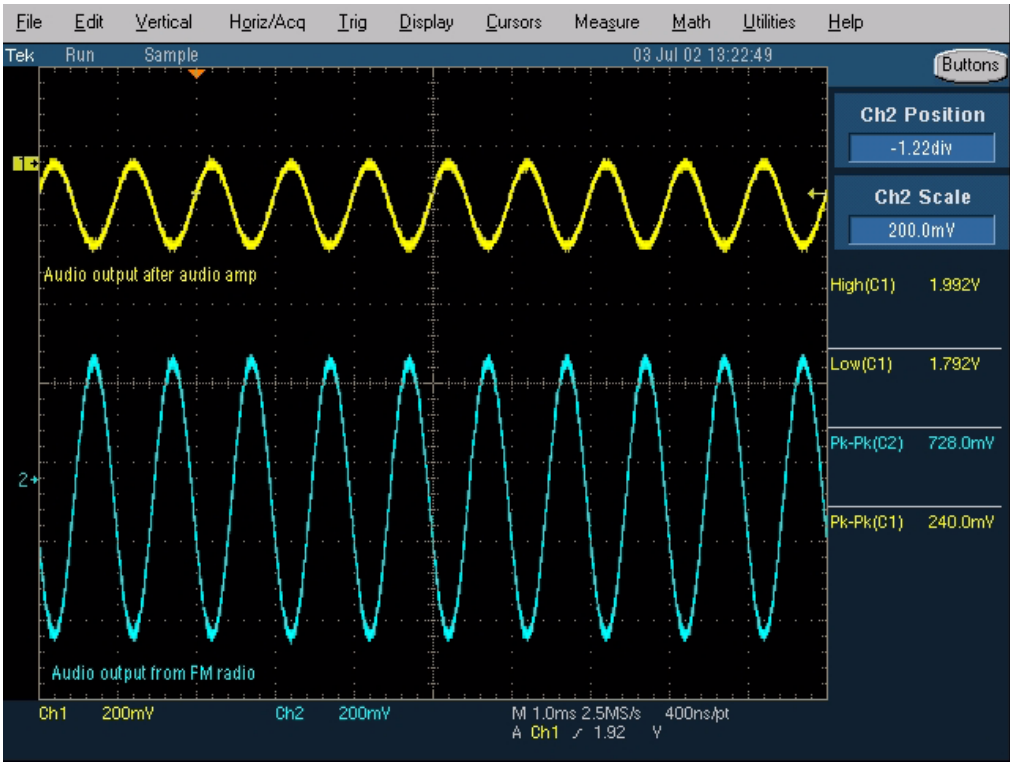

Figure 39: Oscilloscope screen shot, Audio output

Signal 1: Audio output from PWB test points J103 and J104, with FM test signal, volume 100%.

Signal 2: Audio output from FM radio pins 22 and 23(same as in C162 and C163), with FM test signal

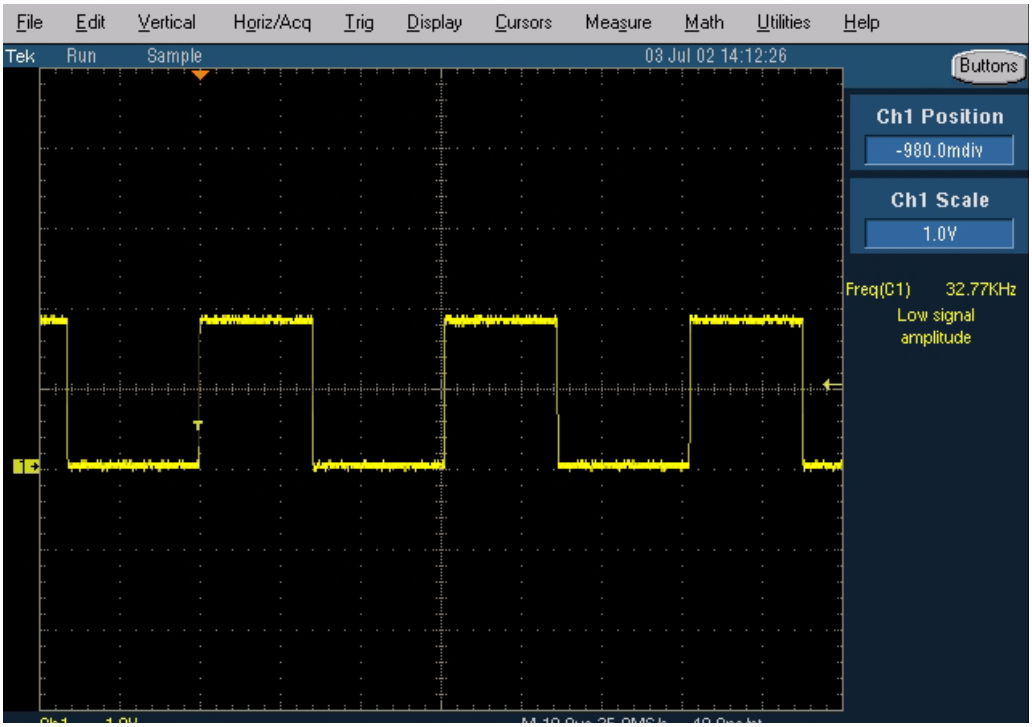

Figure 40: FM radio clock from test point J359, 32 kHz frequency clock signal, when radio is on.

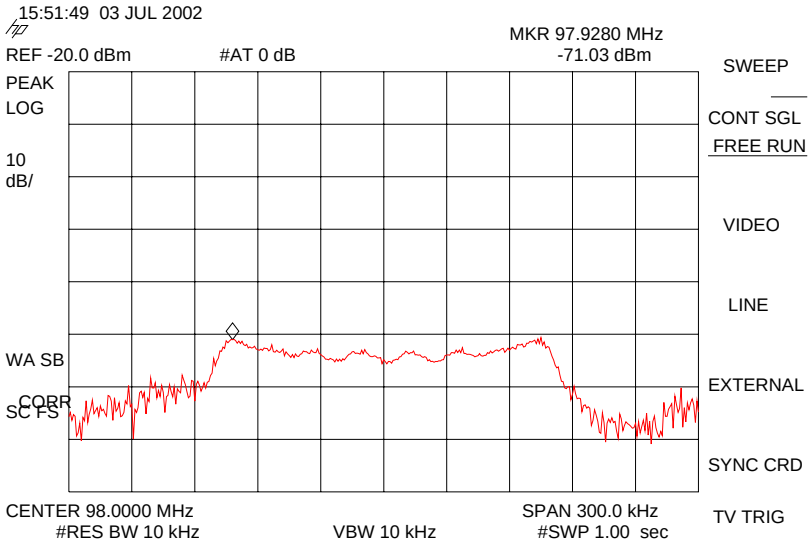

Figure 41: FM frequency from FM radio pin 37, the other end of L358, with FM test signal

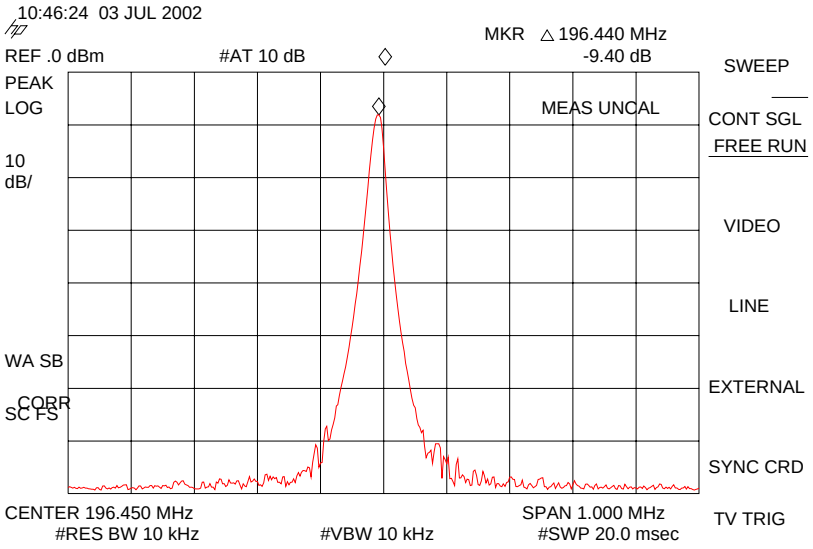

Figure 42: VCO frequency from FM radio pins 3 and 4, the other ends of V356 and V357, with FM test signal